GOBIERNO DE CHILE
FUNDACIÓN PARA LA
INNOVACIÓN AGRARIA

PROGRAMA DE FORMACIÓN PARA LA INNOVACIÓN AGRARIA

APOYO A LA PARTICIPACIÓN EN ACTIVIDADES DE FORMACIÓN

17TH CONGRESO MUNDIAL DE LA CIENCIA DEL SUELO
Agosto 2002, Bangkok, Thailandia
ENFRENTANDO LA NUEVA REALIDAD DEL SIGLO 21

INFORME FINAL
Código FIA-FP-V-2002-1-A-33

Diciembre 2002

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INFORME TECNICO
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CONTENIDO DEL INFORME TÉCNICO

PROGRAMA DE FORMACIÓN PARA LA INNOVACIÓN AGRARIA

1. Antecedentes Generales de la Propuesta

Nombre: **Actualización y captura de información científico tecnológica en el área de la fertilidad de suelos y producción de semillas: 17 Congreso Mundial de la Ciencias dei Suelo.**

Código: **FP-V2002-1**

Entidad Responsable: Postulante Individual: **InternationalSociety of Soil Science**

Coordinador: **Sampong Theera Wong. Presidente del Congreso**

Lugar de Formación (País, Región, Ciudad, Localidad): **Bangkok - Thailandia**

Tipo o modalidad de Formación: **Encuentro Científico**

Fecha de realización: **14 – 21 de Agosto de 2002**

Participantes: presentación de acuerdo al siguiente cuadro:

Nombre	Institución/Empresa	Cargo/Actividad	Tipo Productor (si corresponde)
Rolando Demanet F.	Universidad de La Frontera	Profesor Asociado	

Problema a Resolver:
Actualización del conocimiento básico y aplicado del manejo de fertilización de especies forrajeras destinadas a la producción de semilla, capturar información relevante en el área de la nutrición vegetal y contactar a investigadores de nivel internacional para desarrollar proyectos futuros.

Objetivos de la Propuesta

2. Antecedentes Generales:

Durante el desarrollo del congreso se logró exponer el trabajo "Effect of Boron Fertilier on Red Clover Seed Production in Chilean Volcanic Soils", en la sección posters Symposium N° 14, paper 1696. Además fue posible presenciar y discutir el efecto de la aplicación de micronutrientes en la producción de semilla y especies forrajeras.

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Presentación del Posters en el Quenn Sirikit National Convention Center, Bangkok, Thailandia

Antecedentes Técnicos

Relación Concentración de nutrientes en la planta y el Suelo: De acuerdo a los antecedentes logrados en el congreso la relación planta suelo esta determinada por los componentes químicos y biológicos del suelo y el medio ambiente. En praderas templadas la concentración de macro y micronutrientes se presenta en el siguiente cuadro:

Macronutrientes

Elemento (%)	Suelo	Planta	Planta/Suelo
N	0.28	2.80	10.00
P	0.20	0.40	2.00
S	0.10	0.35	3.50
K	1.50	2.50	1.70
Na	0.25	0.25	1.00
Ca	1.80	0.60	0.33
Mg	0.80	0.20	0.25

Micronutientes

Elemento (ppm)	Suelo	Planta	Planta/Suelo
Mn	1,600	165	0.10
Zn	150	37	0.25
Cu	30	9	0.30
B	50	5	0.10
Mo	2.6	0.90	0.35
Se	0.4	0.05	0.12

Concentración de nutrientes en las plantas: El contenido de nutrientes en las plantas esta determinado por el ambiente, suelo, especie, cultivar y tipo de fertilización. Las gramíneas y forrajeras presentan en promedio diferentes niveles donde el Boro registra su mayor concentración es en gramíneas: Timothy y en leguminosas: Alfalfa.

Concentración de Nutrientes en el follaje de Especies Gramíneas (bms)

Elemento (%)	Ballica perenne	Pasto ovillo	Timothy	Festuca
N	2.10	2.80	2.50	2.60
P	0.32	0.32	0.13	0.30
K	2.30	2.60	1.70	2.10
Ca	0.87	0.57	0.88	0.87
Mg	0.17	0.15	0.27	0.18

Elemento (ppm)	Ballica perenne	Pasto ovillo	Timothy	Festuca
Mn	41	105	38	29
Zn	20	23	19	16
Cu	5.0	7.1	4.6	4.9
B	9	10	17	10
Mo	0.47	0.77	0.58	0.60

Concentración de Nutrientes en el follaje de Especies Leguminosas (bms)

Elemento (%)	Trébol blanco	Trébol rosado	Alfalfa
N	4.42	3.40	2.94
P	0.38	0.27	0.26
S	0.29	0.21	0.27
K	2.26	2.07	1.65
Ca	2.10	1.84	1.82
Mg	0.18	0.21	0.15

Elemento (ppm)	Trébol blanco	Trébol rosado	Alfalfa
Mn	49	44	42
Zn	25	24	24
Cu	7.3	7.4	7.0
B	31	27	38
Mo	0.64	0.44	0.18

La concentración de nutrientes en especies forrajeras no tradicionales es de especial interés en la comunidad científica internacional, dado la gran cantidad de trabajos que relacionan estas especies con propiedades antihelmínticas y de aplicación de la agricultura limpia al área ganadera. El plantago y la achicoria son especies que ya se comercializan en el mercado mundial y en nuestro país el Instituto de Agroindustria ha sido una de las instituciones pioneras en la evaluación del comportamiento productivo. La concentración de nutrientes en el follaje se presenta en el siguiente cuadro.

Elemento (%)	Ballica perenne	Achicoria	Plantago
N	2.07	2.30	2.00
P	0.29	0.42	0.35
K	2.50	5.10	2.30
Ca	0.40	1.60	2.60
Mg	0.14	0.27	0.19

Relación entre el contenido de nutrientes en la planta y el Animal: La capacidad de absorción de nutrientes en los animales depende del tipo de animal y el objetivo de la producción. En producción de leche la excreción es alta y puede alcanzar mas del 95% del nutriente consumido a través del forraje, así lo demuestran los antecedentes presentados por Whitehead (2000).

%	Input		Reserva Animal		Output	
	Consumo	Adsorción	Total	Disponible	Fecas y orina	Leche
	g/día	g/día	g	g	g/día	g/día
Ca	100	34	6,000	3	8	26
Mg	20	4	175	0.75	1.5	2.5
K	50	50	820	185	22.5	28
Na	20	20	700	35	6.5	13

Esta información es de gran relevancia para el desarrollo de los sistemas de producción vegetal, dado que permite aplicar este conocimiento a los sistemas de producción en el país.

3. **Itinerario Realizado**: presentación de acuerdo al siguiente cuadro:

Fecha	Actividad	Objetivo	Lugar
20 Agosto de 2002	Presentación del trabajo "Effect of Boron Fertilier on Red Clover Seed Production in Chilean Volcanic Soils"	Exponer los resultados logrados en la investigación realcionada con el efecto de la fertilización con diferentes dosis de boro en la producción de semilla de Trébol rosado	Queen Sirikit National Convention Center. Bangkok-Thailandia
14 a 20 de Agosto de 2002	Participación en los difrentes sympisium del congreso mundial de las ciencias del suelo.	Capturar información en el área de la nutrición vegetal, incrementar el conocimiento científico tecnológico en el manejo de micronutrientes y promoción de Chile en la comunidad científica como país productor de semilla de Trébol rosado.	Queen Sirikit National Convention Center. Bangkok-Thailandia

4. Resultados Obtenidos:

Los resultados obtenidos en la actividad realizada en Tailandia, estan referidos a la adquisición de conocimientos en el área de la producción vegetal y en especial, al reciclaje de nutrientes y la generación de sistemas de control de manejo de nutrientes que tienen por objetivo la obtención de una agricultura mas limpia y amigable con el medio ambiente. Este tema que es recurrente en la mayoría de las presentaciones del congreso se reflejan en los datos que se presentan a continuación en relación al balance de nutrientes, en especial micronutrientes, que fue el objetivo principal de mi participación en el congreso.

Relación entre la concentración de nutrientes en el animal y las plantas: Para desarrollar modelos de balnaces nutricionales en los sistemas ganaderos es necesario conoccre la relación entre la concentración de nutrientes en los animales y las plantas, en especial, en los animales de tipo rumienates.

Macronutrientes

Elemento (%)	Planta	Animal	Animal/Planta
N	2.80	9.00	3.20
P	0.40	2.66	6.70
S	0.35	0.50	1.40
K	2.50	0.67	0.27
Na	0.25	0.50	2.00
Ca	0.60	4.66	7.80
Mg	0.20	0.15	0.75

Micronutrientes

Elemento (ppm)	Planta	Animal	Animal/Planta
Mn	165	1.2	0.007
Zn	37	83	2.2
Cu	9	9	1
B	5	1	0.2
Mo	0.90	0.66	0.83
Se	0.05	1.2	24

La distribución de los nutrientes en los procesos productivos es de vital importancia para lograr la definición de las pérdidas de eficiencia y los niveles de contaminación que se obtienen en sistemas de alta concentración animal bajo pastoreo.

Nutriente	Concentración Follaje %	Consumo g/día	Secreción 25 kg Leche g/día	Fecas g/día	Orina g/día
P	0.41	66	24	48	0.2
S	0.42	67	7	18	42
K	3.02	483	41	53	389
Na	0.37	59	10	9	40
Ca	0.61	98	30	68	0.5
Mg	0.23	37	3	31	3.0

Uno de los nutrientes de mayor utilización en los sistemas de producción es el nitrógeno, sin embargo, se ha transformado en el elemento de mayor contaminación en los sistemas ganaderos, debido a la alta excreción que este presenta en los sistemas ganaderos y alta volatilización, lixiviación y pérdida por arrastre en las áreas de aplicación de altas dosis de fertilizantes nitrogenados.

Tipo Animal	Fertilización kg N/ha/año	% N Follaje bms	Bosta kg N/ha	Orina kg N/ha	Orina % N Excretado
Vacas	250	3.3	86	214	71
	540	4.1	104	354	77
Novillos	0	2.8	58	74	56
	210	3.1	62	93	60
	420	3.7	84	237	74

Balance de Nutrientes: Uno de los puntos de mayor relevancia para el desarrollo futuro de la investigación que desarrolla nuestra institución en el área de la nutrición vegetal son los modelos desarrollados por diferentes investigadores en el área de praderas y pasturas, dado que en la actualidad nuestra Universidad trabaja en forma activa a través del grupo de química de sulos y manejo agronómico en nutrientes como azufre y oligoelementos. En este ámbito se presenta a continuación el efecto de la aplicación de azufre en la ganancia de peso de corderos alimentados con dos tipos de praderas.

	Fertilización S (kg/ha)		
Ballica	**0**	**45**	**90**
% N Follaje	1.66	2.03	2.04
% S Follaje	0.14	0.18	0.2
N:S	12.3	11.3	10.3
Consumo kg/día	1.57	1.65	1.71
Ganancia peso g/día	141	180	207
Ballica + Trébol			
% N Follaje	1.12	1.17	1.24
% S Follaje	0.09	0.17	0.21
N:S	12.4	7.1	6
Consumo kg/día	1.3	1.27	1.58
Ganancia peso g/día	32	88	113

En micronutrientes se presentaron trabajos relacionados con el balance de micronutrientes: Mn, Se, Mn, Zn y Cu, en sistemas intensivos de producción de leche bajo pastoreo en praderas manejadas con la mezcla *Lolium perenne* + *Trifolium repens.*, cuyos resultados se presentan en los siguientes cuadros.

Balance de Boro, Molibdeno y Selenio en Pradera de Ballica perenne + Trébol blanco

	B	Mo	Se
Inputs			
Fertilización	6	7	0.3
Atmósfera	150	2	3
Reciclaje			
Absorción Forraje	150	40	10
Consumo animal	120	32	8
Material muerto	60	16	4
Raíces muertas	60	20	3
Excretas	96	26	6.5
Output			
Leche	7	0.7	0.2
Pérdida por lluvia	60	1	1
Pérdida por excretas	17	5	1.2
Ganancia/Pérdida en el suelo	82	2	0.6

Balance de Boro, Manganeso, Zinc y Cobre en Pradera de Ballica perenne + Trébol blanco

	Mn	Zn	Cu
Inputs			
Fertilización	15	7	2
Atmósfera	100	700	210
Reciclaje			
Absorción Forraje	1000	600	150
Consumo animal	800	480	120
Material muerto	400	240	60
Raíces muertas	1000	200	125
Excretas	540	405	110
Output			
Leche	0.25	42	0.7
Pérdida por lluvia	2.5	2.3	0.7
Pérdida por excretas	95	70	20
Ganancia/Pérdida en el suelo	580	190	6

5. Aplicabilidad:

Los conocimientos adquiridos en el área de la nutrición vegetal y su relación con la producción vegetal y animal tendrán una rápida aplicabilidad en Chile, dado que ya se esta trabajando con estos nutrientes verificando el comportamiento de ellos bajo las condicones de suelos volcánicos con riesgo de acidificación.

En praderas, el conocimiento de los balances de nutrientes nos permitirá dar exc¿plicación al comportamiento animal, sometido a diferentes niveles de concentración de nutrientes en el suelo y las plantas.

La mayor aplicación estará dada en el área de la producción de praderas para producción animal, rubro que debe competir en productividad, calidad y manejo de los recursos medio ambientales, que son cada día mas exigentes en los potenciales países consumidores.

6. Contactos Establecidos: presentación de acuerdo al siguiente cuadro:

Institución/Empresa	Persona de Contacto	Cargo/Actividad	Fono/Fax	Dirección	E-mail
University Helsinky	Helina Hartikainene	Professor	358919158323/358919158475	Box 25, Helsinki, 00014, Finland	Helina.Hartikainen@helsinki.fi
Universita di Napoli	Antonio Violante	Professor	397885208/397755130	Napoli, 80055, Italia	vloeante@unira.it
University of Waikato	David Holmes	Professor			holmes@landcare
University of Saskatchewan	Pan Ming Huang	Professor	(306)966-6838/(306)966-6881	51 Campus Drive, Saskatoon, SK,S7N 5A8, Canadá	huangp@sask.usask.ca

7. Detección de nuevas oportunidades y aspectos que quedan por abordar:

Durante el desarrollo del congreso se hicieron contactos para continuar trabajando en el estudio de la relación de micronutrientes y la producción vegetal orientada a la producción animal y de semilla. Se espera en los próximos años organizar Congresos en el área de nutrición vegetal y reciclaje de nutrientes, una vez terminados las investigaciones que nuestra universidad se desarrolla en dicho campo.

8. Resultados adicionales:

En forma adicional, fue posible contactar a expertos en el área de los micronutrientes, con el objetivo que estudiantes de post grado, realicen pasantía en sus laboratorios, con el objetivo de potenciar el doctorado que posee nuestra universidad en recursos naturales.

9. Material Recopilado:

Se adjunta fotocopia de los principales papers que fueron consultados para realizar este informe y las tapas de los libros adquiridos en los stand del congreso.

10. Aspectos Administrativos

10.1. Organización previa a la actividad de formación

a. Conformación del grupo

____ muy dificultosa _X___ sin problemas ____ algunas dificultades

(Indicar los motivos en caso de dificultades)

b. Apoyo de la Entidad Responsable

_X___ bueno ____ regular ____ malo

(Justificar)

c. Información recibida durante la actividad de formación

_X___ amplia y detallada ____ aceptable ____ deficiente

d. Trámites de viaje (visa, pasajes, otros)

_X___ bueno ____ regular ____ malo

e. Recomendaciones (señalar aquellas recomendaciones que puedan aportar a mejorar los aspectos administrativos antes indicados)

10.2. Organización durante la actividad (indicar con cruces)

Ítem	Bueno	Regular	Malo
Recepción en país o región de destino	X		
Transporte aeropuerto/hotel y viceversa	X		
Reserva en hoteles	X		
Cumplimiento del programa y horarios	X		

En caso de existir un ítem Malo o Regular, señalar los problemas enfrentados durante el desarrollo de la actividad de formación, la forma como fueron abordados y las sugerencias que puedan aportar a mejorar los aspectos organizacionales de las actividades de formación a futuro.

11. Conclusiones Finales

La participación en el 17° Congreso Internacional de las Ciencias del Suelo, permitió, actualizar los conocimientos en el área de mi especialidad y desarrollar diversos contactos con investigadores relacionados con el tema de la fertilidad de suelo y nutrición de especies pratenses destinadas a la producción de producción forrajera y semilla.

12. Conclusiones Individuales:

En el 17° Congreso de la ciencias del suelo participaron mas de dos mil investigadores y se presentaron 64 symposium diferentes relacionados con las áreas de Física, Química, Biología y Fertilidad de suelos, Nutrición de plantas, Génesis y Cartografía, Mineralogía, Tecnología de uso del suelo, Manejo del medio Ambiente, Micromorfología, Conservación de agua y suelo, Manejo de suelos salinos, Conservación de suelos forestales y Remediación de suelos

La mayor proporción de trabajos presentados tenían relación con la conservación del recurso suelo y los alcances del incremento de la contaminación con nutrientes que habitualmente incrementa la producción de los cultivos y praderas. La investigación desarrollada en el mundo tiene una clara tendencia a la protección de los recursos naturales y a la disminución de la fertilización, principal contaminante de las aguas subterráneas y océanos. Junto a lo anterior se encuentran los procesos de remediación, cuyo objetivo principal es lograr un ambiente mas amigable con el ambiente donde se desarrollaran las futuras generaciones de seres humanos.

Fecha:

Nombre y Firma coordinador de la ejecución:

AÑO 2002

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17TH CONGRESO MUNDIAL DE LA CIENCIA DEL SUELO
Agosto 2002, Bangkok, Thailandia
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POSTERS PRESENTADO

Effect of Boron Fertilizer on Red Clover Seed Production in Chilean Volcanic Soils

Rolando Demanet F. and María de la Luz Mora G.
Universidad de La Frontera, PO-Box 54-D, Temuco-Chile
email: rdemanet@ufro.cl

INTRODUCTION

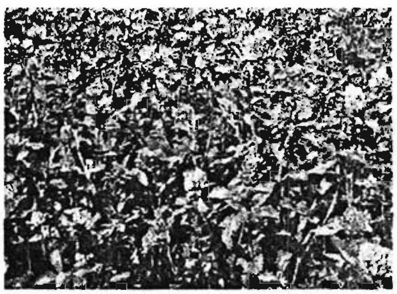
The Ninth Region, 37-39 °S, 74 -71 °W, has a climate alike to that of temperates seed growing areas of the world. Rainfall averages 1,400-2,000 mm *per annum*. The two soil groups used for growing seed are classified as Ultisol and Andisol. Ultisols have phosphate retention of aproximately 60 % and organic matter of approximately 9 %, whereas Andisols have high phosphate retention (approximately 90 %) and high organic matter (16-18 %). *Trifolium pratense* L. seed production area reaches to 5,000 ha in Southern Chile and the average yield is less than 300 $kgha^{-1}$. The principal factor which regulates the crop production is high acidity condition in these soil, hampering nutrient availability. Boron is highly deficient in these soil. The Data Base of Soil Service Laboratory in the Universidad de La Frontera indicates that the 50 % of soils have less than 0.5 mg kg^{-1}. The availability of boron to the plants generally decreases with an increase in soil pH, resulting in lime-induced boron deficiency in some cases. Boron play an important role in pollination process and deficiency affects pollen germination and pollen tube growth in the plant. Boron is also involved in many other essential processes, including the translocation of sugar and other biochemicals, protein synthesis, nodule formation in legumes and regulation of carbohydrate metabolism (McLaren and Cameron, 1994)

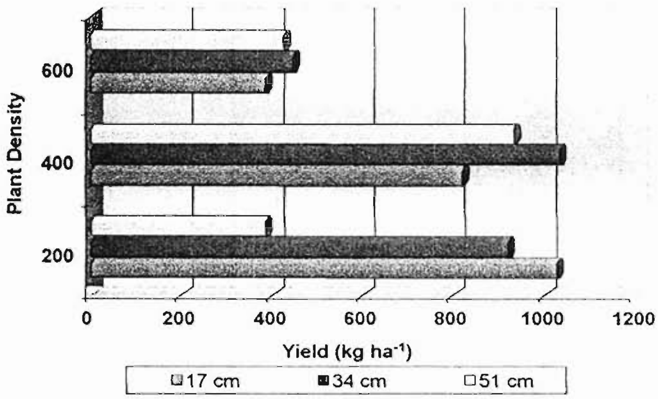
OBJECTIVE

The aim of this work was to determine the boron fertilizer requirements on Trifolium pratense L. seed production growing in volcanic ashes derived soils.

Soil Chemical Properties

Soil Serie	Fresia
pH	5.5
B (mg kg^{-1})	32
S (mg kg^{-1})	10
P (mg kg^{-1})	9
Exchangeable capacity	
Ca	3.6
Mg	0.7
K	0.3
Al	0.5
Σ (K, Ca, Mg, Al)	5.1
Al saturation (%)	9.8



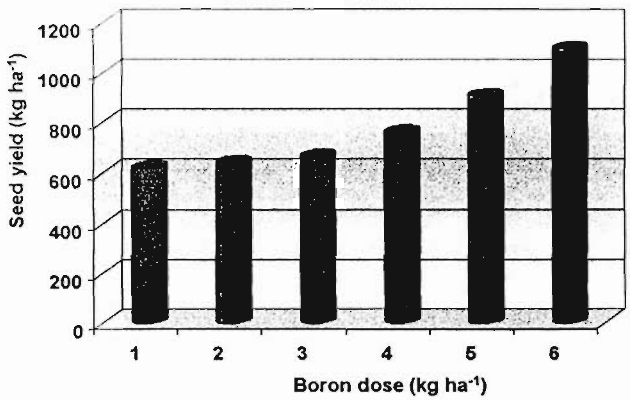


Effect of Plant Density and Row Distance on Red Clover Seed Production

MATERIALS AND METHODS

The research was developed in an Andisol of Freire Serie with 0.32 mg kg^{-1} of Boron and pH 5.5. A split plot design with four replicate was used to evaluated the effect of 5 dosis of boron fertilizer. The dosis were 0, 1,2,3,4 and 6 kg B ha^{-1}. Previously seedling the soil was liming with 1 ton of calcite. The experiment was conducted by two years (1999/2000 and 2000/2001). The boron source was calcite boronatre applied in the first year in the row and overcastted in the second year.

Effect of Boron Dose on Red Clover Seed Production
Season 1999/2000



CONCLUSIONS

The result indicate a very good relationship between boron dosis and yield. In the first year the maximum average yield was 1,096 kg ha-1 when it was apply 6 kg of B ha-1. With the same dosis in the second year the average yield was 1,401 kg ha-1. The yield increase from 24% to 73% with the boron rate from 1 kg ha-1 to 6 kg ha-1 reaching in the soil over 1 mg kg-1 . The increase boron in the soil depend the interaction liming and boron rate and also of plant density and row distance .

References

McLaren R.G. and Cameron K.C., 1994. Soil Science. Oxford University Press, Auckland. New Zealand. 294 p.

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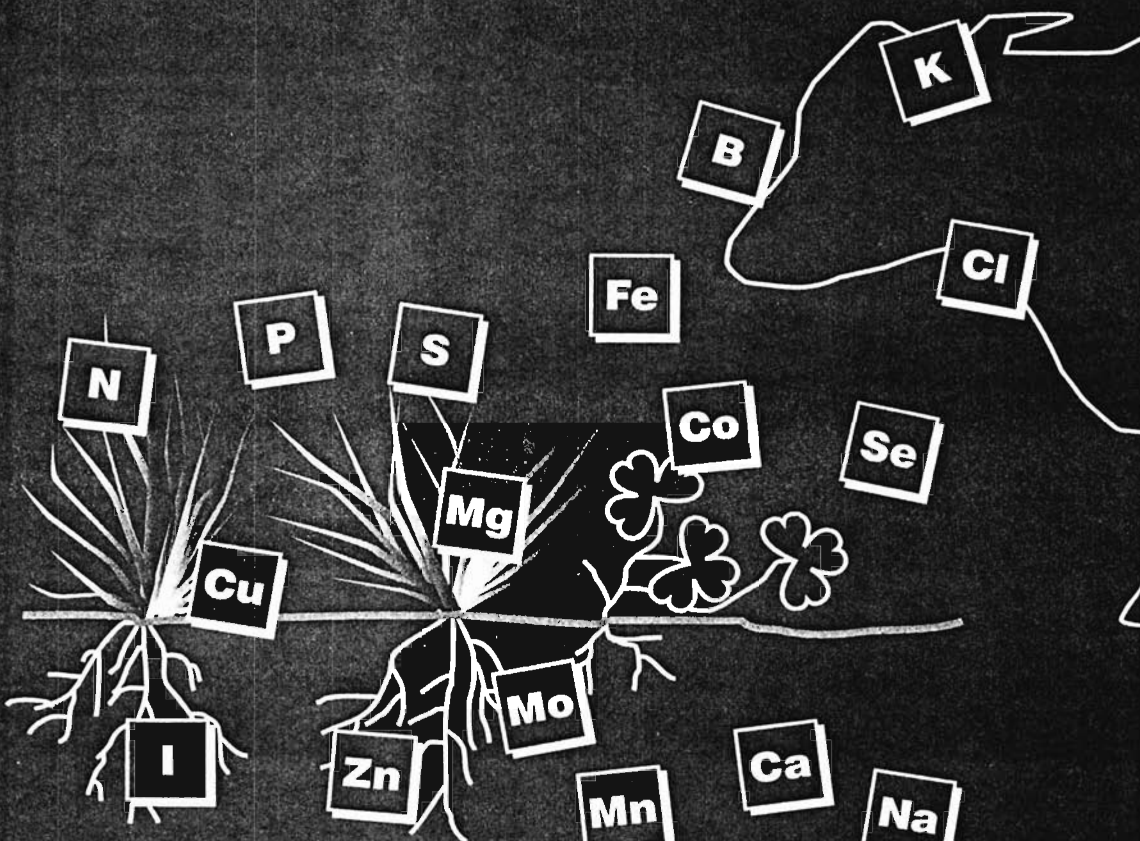
LIBROS ADQUIRIDOS EN EL CONGRESO

NUTRIENT ELEMENTS IN GRASSLAND

SOIL-PLANT-ANIMAL RELATIONSHIPS



David C. Whitehead

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CABI Publishing
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Contents

Preface

This book is concerned with the various chemical elements that are nutrients for either plants or animals. Its primary objective is to bring together information on the concentrations and main transformations of these elements in soils, in grassland plants and in ruminant animals. The data are restricted to those relevant to the grassland areas of temperate regions: data from tropical grasslands are not included. For each element, attention is given to its forms and availability in soils, its uptake and distribution in grassland plants, its role in animal nutrition and the amounts and forms excreted by grazing animals. The influences of soil, plant, weather and management factors on the concentrations of the elements in grassland herbage are described and the concentrations related to the needs of ruminant animals, particularly cattle and sheep. In addition, typical annual balances of the inputs and outputs of each element, on a per hectare basis, are estimated for both intensively managed and extensively managed grassland.

The book will probably be used mainly as a source of reference, and the way in which the chapters are subdivided and the extensive list of references are intended to facilitate this type of use. Readers are assumed to have a basic knowledge of soil science and plant and animal physiology, but a glossary of some of the more specialized terms is included. For the sake of brevity, chemical symbols of the elements are used in the text and, although all the elements often occur as ions, the electrical charge (+ or −) is indicated only where there is specific reference to the ionic form.

In compiling this book, I have drawn partly on information gathered during a period of more than 25 years spent at the Grassland Research Institute, Hurley, UK, until its closure in 1992. Since that time, secondment from the North Wyke Research Station of the Institute for Grassland and Environmental Research and a subsequent Fellowship in the Department of Soil Science at the University of Reading have provided access to the University Library, which has been a major source of additional information.

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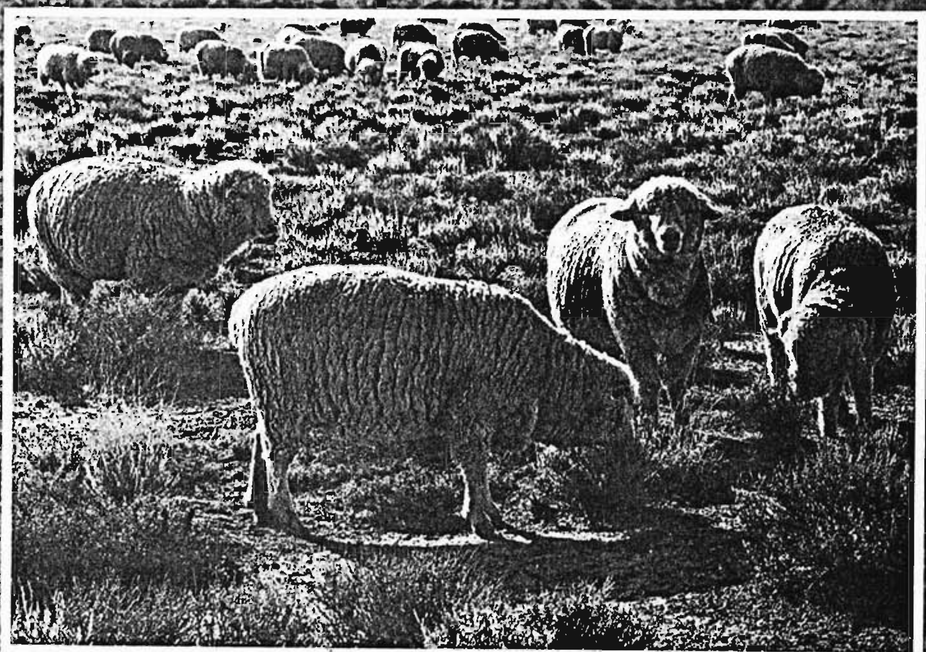
GRAZING MANAGEMENT



John F. Vallentine

SECOND EDITION

GRAZING MANAGEMENT

JOHN F. VALLENTINE

Emeritus Professor of Range Science
Brigham Young University
Provo, Utah

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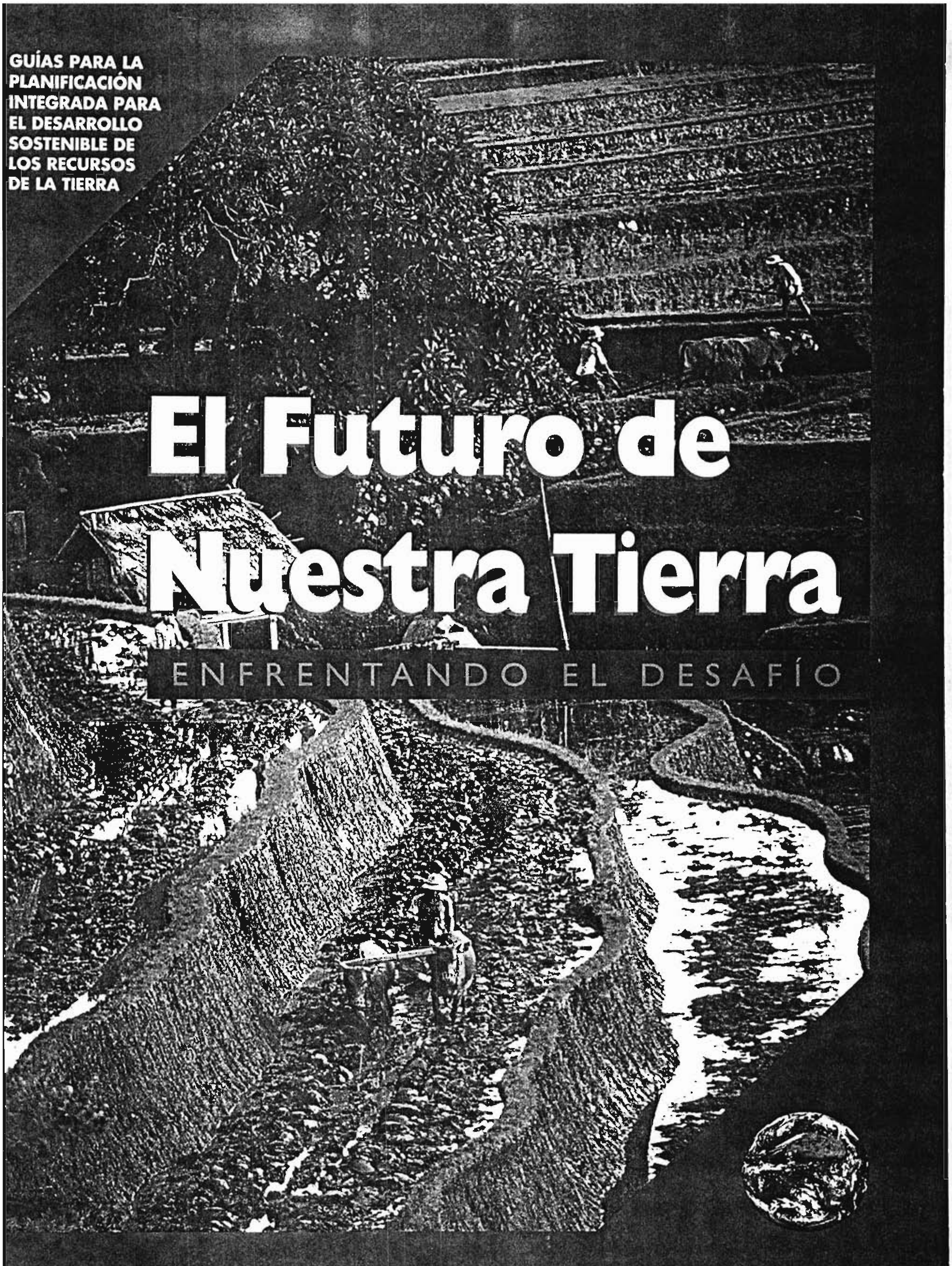

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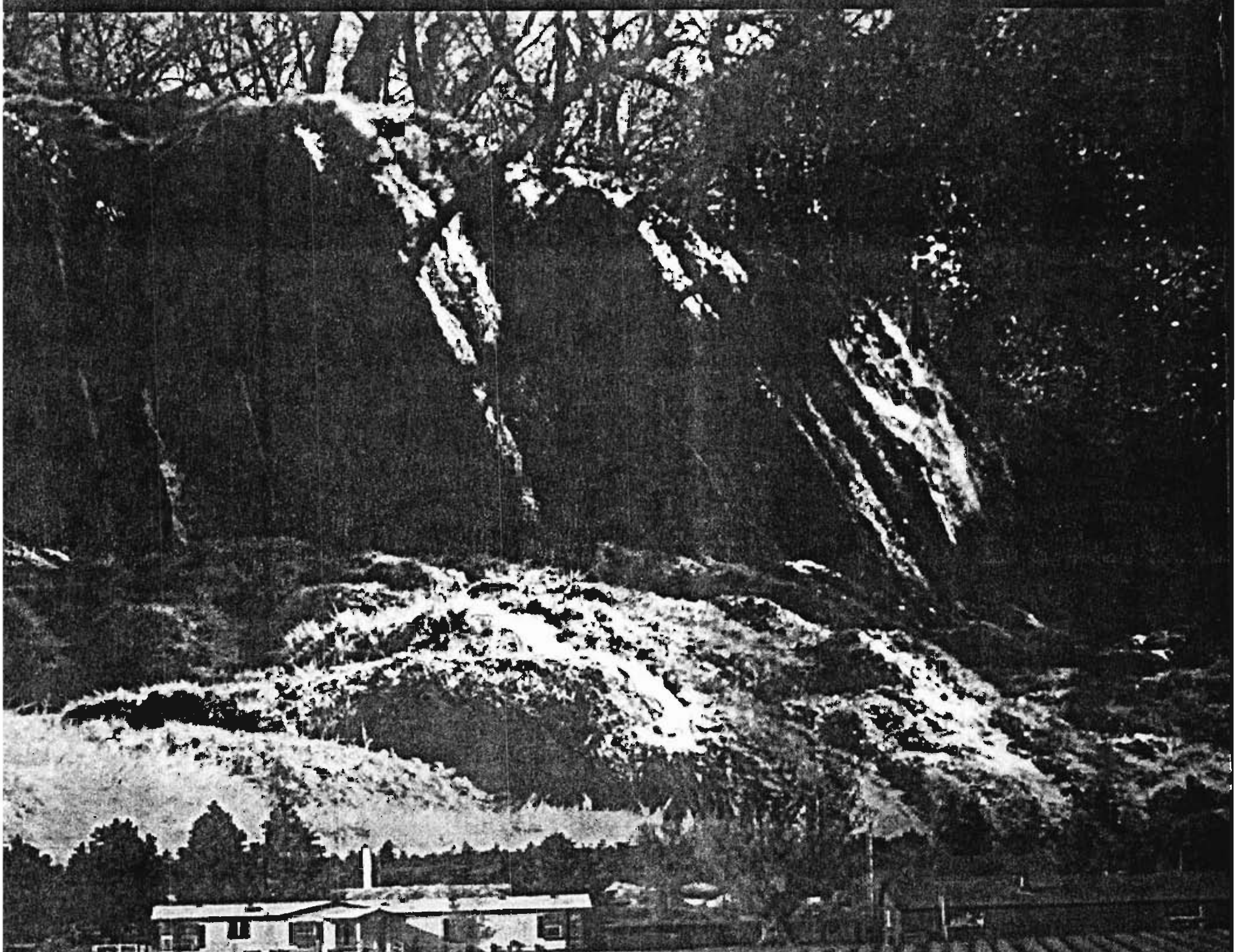

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Edward J. Plaster

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Para más información:

México y América Central
Séneca, 53, Colonia Polanco
México, D. F. 11560
Tel: 525-281-2906 Fax: 525-281-2656
e-mail: clientes@mail.internet.com.mx
MEXICO

El Caribe
Tel: 787-758-7580 Fax: 787-758-7573
e-mail: 102154.1127@compuserve.com
Hato Rey, PUERTO RICO

América del Sur
Tel. (54-11) 4325-2236
Fax. (54-11) 4328-1829
e-mail: sdeluque@ba.net
Buenos Aires, ARGENTINA

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WCSS 2002

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Soil Science : Confronting New Realities in the 21st Century

PROGRAMME

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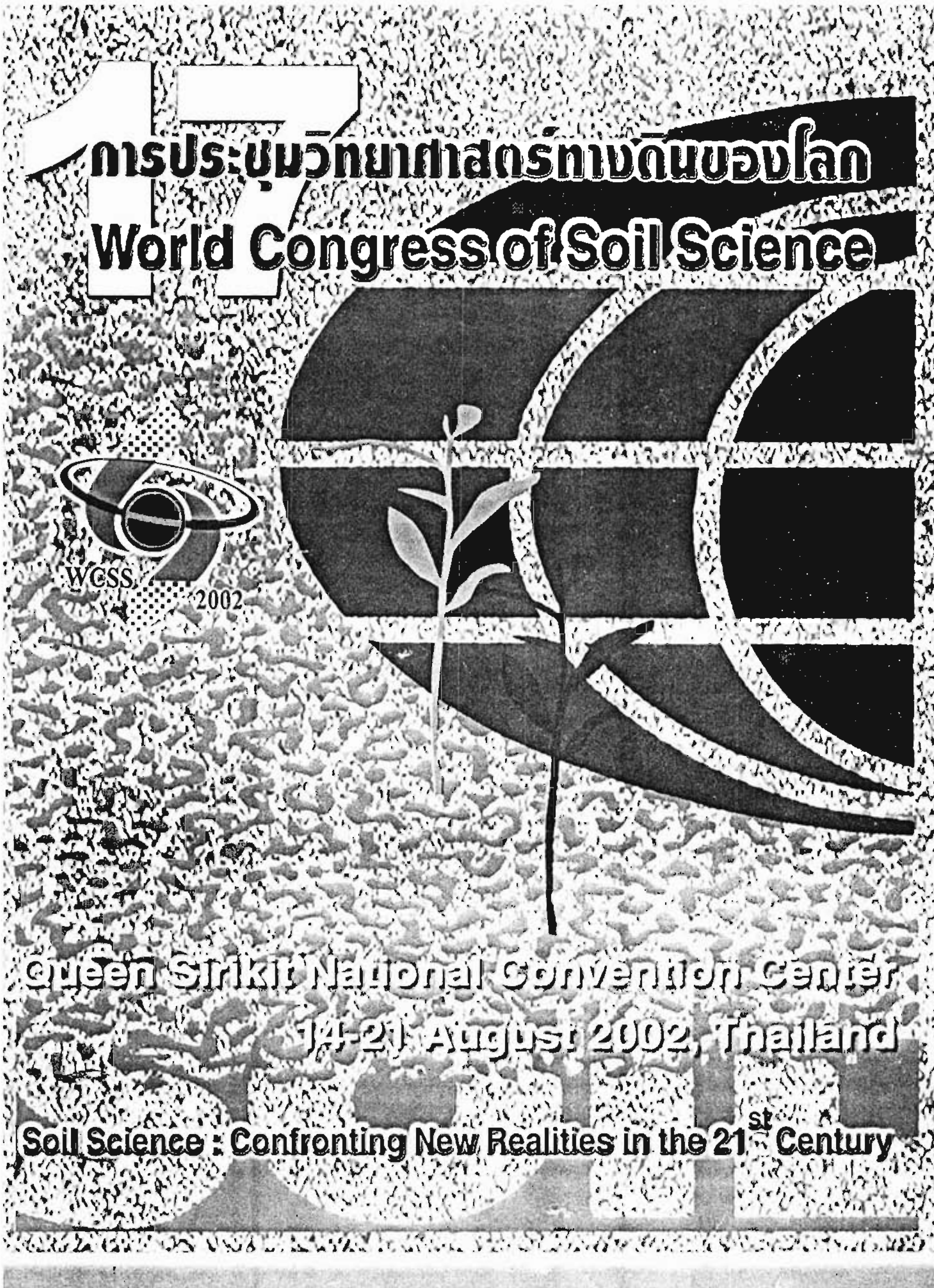
WASWC WORLD ASSOCIATION OF SOIL AND WATER CONSERVATION



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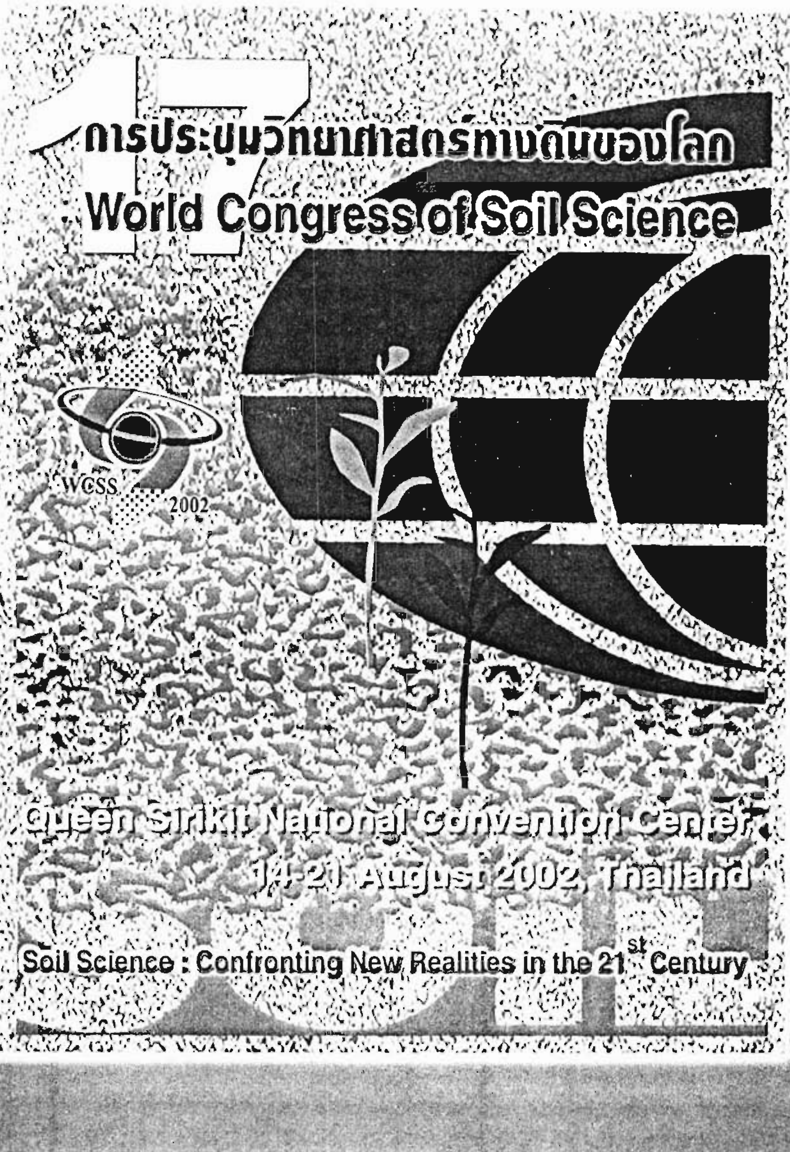


KEYNOTE LECTURES

FOOD & FERTILIZER TECHNOLOGY CENTER FFTC 1970

WASWC WORLD ASSOCIATION OF SOIL AND WATER CONSERVATION

URUSHADZE Tengiz F.
President of Georgian Soil Science Society, Georgia, Tbilisi

"Soil is the pellucle of life on the earth. Preservation of soils for the current and future generations is a difficult but honorable task. There is no life without soil, just as there is no soil without a soil scientist."

Soils in space and time: realities and challenge for the 21st century

URUSHADZE Tengiz F.

Georgian Society of Soil Science, 52, Rustaveli av. 380008 Tbilisi, Georgia

Abstract

Soil is an essential part of the biosphere. Owing to the soils major mass of organic substances are produced on land. Soils are the basis for land plantations which use solar energy 9 times as intensively than ocean organic substances. Many significant elements in the biosphere flow through the soils: carbon, oxygen, nitrogen, potassium, magnesium, phosphorus, sulfur etc. The main peculiarity of soils is to accumulate organic substances, various chemicals as well as energy. Soils function as biological adsorbent, distracter and neutralizer of different pollutants.

Soils as natural-historical body have two alternative ways of development:

1. Natural or
2. Anthropogenic

For the natural development of soils a period of one hundred years is immaterial and may not cause radical changes of soils and soils cover.

More important way of development is the anthropogenic one. As a rule this way is negative and is connected with the influence of different extents on soils. This leads to the violation of natural processes, degradation and final destruction.

In the process of scientific and technical progress, development and opposition of different political systems, permanent bloody conflicts our planet has considerably changed its appearance. The 20th century was the era of spontaneous, planes and scientifically ungrounded stage of development of our civilization.

In the 21st century no natural drastic changes of soils in time and space are expected. But anthropogenic changes of soils may be intensive. This process is extremely negative today and beyond our control. Decisive measures must be taken in this direction.

The first stage-the world database on the conditions of soils and soils cover must be created.

The second stage-to systemize world experience of soils protection and their rational use.

The third stage-to organize effective worldwide monitoring of soils and soils cover.

Keywords: Anthropogenic changes, soil degradation, soil protection, soil function, world soil database

Introduction

Soil is an essential part of the biosphere. Owing to the soils major mass of organic substances are produced on land. Soils are the basis for land plantations which use solar energy 9 times as intensively than ocean organic substances. Many significant elements in the biosphere flow through the soils: carbon, oxygen, nitrogen, potassium, magnesium, phosphorus, sulfur etc. The main peculiarity of soils is to accumulate organic substances, various chemicals as well as energy.

Soils function as biological adsorbent, distracter and neutralizer of different pollutants. According to Kovda (1989) soil is an indispensable part of the general mechanism of the biosphere. If this biosphere link is destroyed then the biosphere functioning will be considerably violated. Soil cover is a "life screen" as an ozone screen of stratosphere.

Soils as natural-historical body have two alternative ways of development:

1. Natural or
2. Anthropogenic

For the natural development of soils a period of one hundred years is immaterial and may not cause radical changes of soils and soils cover.

More important way of development is the anthropogenic one. As a rule, this way is negative and is connected with the influence of different extents on soils. This leads to the violation of natural processes, degradation and final destruction.

In the process of scientific and technical progress, development and opposition of different political systems, permanent bloody conflicts our planet has considerably changed its appearance. The 20th century was the era of spontaneous, planes and scientifically ungrounded stage of development of our civilization. According to Vernadsky (1926) biosphere has turned into noosphere - the sphere of mind and anthropogenic press.

The 20th century was the era of considerable decrease of natural soil areas.

Soils of the world differ according to their histories and the speed of soil formation (Lobova and Chabarov, 1983).

More ancient soils are formed in a tropical zone. According to Leneuf (1959) the formation of one meter of soil pedosphere in tropics takes 20-77 milleniums. The soils in tropics vary according to the extent of weathering. Tropical soils are ferrallitic, kaolinite and iron. The general properties of soilss are acid reaction, low adsorbing capacity and desaturation, fulvates, weakly polymerous humus, a small amount of mineral reserves. Soils are also characterized by intensive accumulation of kaolonotes on acid rocks and slow accumulation - on basic rocks.

Since the Tertiary period tropical soils areas have been decreasing. This is proved by kaolinite derivatives and laterite soils not only in subtropical, but in boreal and subboreal zones as well. Though even nowadays tropical soils are considered as the most spread type in the world. For example, allitic and ferrallitic acid soils of humid tropical climate make 15.83 percent of the entire land on our planet, while shallow acid and neutral soils of dry tropical climate occupy – 7.74 percent.

Subtropical zones inherited from products zones allitic and mainly kaolinite products of weathering, which are not fertile and are resistant to weathering. Wide zone of subtropics is especially developed on Eurasian continent. The soils cover of the subtropical zone is quite diversified, due to the fact that the intensity of weathering is not high enough to smooth out rock influence.

Subtropical zones are the territories where agriculture has existed for milleniums. The influences the development of soil erosion and deteriorates soil properties.

Subtropical soils are mainly used under food and industrial crops.

Subtropical soils occupy a considerable part of the land. For example, fersiallitic acid, less frequently neutral soils of humid subtropical climate occupy 3.42 percent of the entire land on our planet, while neutral and weakly leached soil of dry subtropical climate occupy – 5.46 percent.

Subboreal zone mainly embraces young soil zone formed in post-glacier epoch or a bit earlier in Pliocene. Subboreal zone is spread in Western America, Eastern Europe, Central and Eastern Asia. It involves steppe, semi-desert and desert soils. The main characteristics of these soils are isohumus profile, humate humus, weak weathering of the mineral part of soil profiles. This zone also occupies considerable areas. For example, neutral or leached soils of subboreal moderate warm climate occupy 5.25 percent of the entire land.

Desert zones occupy considerable areas in Africa, Australia, Central Asia and Middle East. Comparatively small areas of deserts are observed in South America. In this zone fully developed soils are formed both on more ancient surfaces and on alluvial rocks; on solid rocks clay crust of the same content is formed. Carbonate salinized desert soils occupy 6.22 percent of the entire land of our planet.

In the borreal zone soils are mainly formed under forests and marsh plants. The age of these soils is 5-10 milleniums. Acid and low acid soils of borreal moderate cold climate occupy 8.47 percent of the entire land, while acid frosting or frost soils of borreal cold climate occupy 3.19 percent.

Soils of subarctic and arctic zones are generally full of base saturation, mainly carbonate and salinized, low capacity and stony. These soils occupy considerably small areas - criogenic neutral and shallow acid and acid soils of subarctic climate - 2.63 percent of the entire land.

All the above refers to the natural ecosystems and considerably virgin soils. Unfortunately, we witness an intensive process of the destruction of ecosystem.

Forests are cut down on vast territories. Besides many forest in the world disappear due to mass destruction of trees. Besides Africa desertification involves some regions in South America and South-East Asia. The process of salinization of irrigation soils is strengthened and extended. Most of the rivers in the world are mineralized and polluted. Deforested mountain slopes, fields, pastures, plains are destroyed by torrents, landslides, erosion, floods and sediments. Total number of nature disasters of various types doubles every 20 years, consequently increases the number of victims. Infant mortality and various diseases (cancer, lungs, heart) have become more frequent. The investigations have shown (Elinder, 1999 in Agroecology, 2000) that immigrants from England to the USA get diseases with this disease is much more frequent. In the USA heart diseases make 35 percent due to the high content of CO (Beevets *et al.*, 2000, in Agroecology, 2000). Military operations have permanent character in many countries of the world.

The role of soils and soil cover in the biosphere is constantly increasing. Soil cover is an ecological niche, asylum and place of concentration of organic substances. The plant in the ecosystems with soil cover annually state nearly n.1017 kcal of chemically active energy. Soils themselves accumulate and retain as organic substances about n.1019 kcal energy. Soil and plant covers retain the accumulated energy in humus, peat, sapropel and carbons for hundreds, thousands and millions of years. According to Kovda (1989) energy of humus and debris serves as a base of existence and soil-forming activities of animals and microorganisms as well as the basis of soil fertility. Soil and plant cover in the process of their development acquire the ability to fix air molecular nitrogen and turn it into amino acids and albumens.

The formation of biomass is followed not only by the fixation of clemically useful energy but by the mobilization and carrying-out to the surface and to upper horizons huge masses of chemical elements and compounds.

The role of soils is very important in earth hydrological cycles and hydrosphere, in the gas regime of planets and the formation of air composition. Photosynthesis, connection of carbon dioxide, nitrogen fixation, emission of oxygen, hydrogen, denitrification, respiration, oxidation and the age of the part of carbon dioxides in air - all these processes, characteristic for soil and plant cover ecosystems, determine both minor local and global cycles.

All the components of biosphere and major biochemical processes are closely interrelated. Soil cover is a special cover of our planet and is a vital link in the bioenergetic balance of the biosphere.

In the second half of the 20th century production of corn per capita decreased in some countries of Africa and Asia. As a result processes of import-export became more intensive (Figure 1). In the middle of 1980s total amount of export by western countries reached 200 million tons per year.

In most countries of Africa, Asia and South America the only available means of heating is wood. More than 1.5 billion people in the world use wood

for heating. Cuttings of wood in many countries prevail annual increase of wood biomass. Thus, about 140 million people in 30 countries suffer from food and fuel shortage. Wood cuttings for heating is an essential factor causing erosion and desertification of soils. Low soil fertility, famine, lack of fuel, insanitary and extreme poverty are main reasons for low life expectancy, high mortality rate both of adults and infants in many developing countries.

The population of the world and the rate of its growth is permanently and systematically increasing (Tables1 and 2).

In 1982 the average rate of increase was 146 people per minute i.e. 77 million per year. In 1986 total number of population amounted 5 billion, in 1993 - 5.5 billion, in 2000 - more than 6 billion, by 2025 it will reach - 8.5 billion, by 2050 - 12.5 billion.

In 1990 the majority of the population was rural, by 2030 urban population will have exceeded rural population twice. By 2100 population of Africa will have increased 6 times compared with 1985, population of South Asia - 3.5 times, Latin America - 3.2 times, North America - 1.3 times, Europe - 1.1.

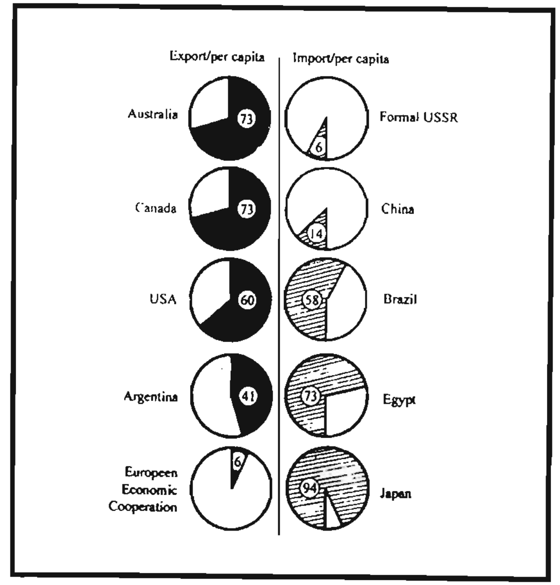


Figure 1 The world export-import of corn (% from produced).

Table 1 Population of the world (Baade, 1968 in Agroecology, 2000).

Period	Grow, million people	Time of doubling the number, years
7000- 4500 BC	from 10 to 20	2500
4500 - 2500 BC	from 20 to 40	2000
2500 - 1000 BC	from 40 to 80	1500

1000 - 0 BC	from 80 to 160	1000
0 - 900 AD	from 160 to 320	900
900 - 1700	from 320 to 600	800
1700 - 1850	from 600 to 1200	150
1850 - 1950	from 1200 to 2500	100
1950 - 1990	from 2500 to 5000	40

Between 1965 - 1970 the rate of the growth reached its maximum in the history of mankind - 2.1 percent per year.

Table 2 The dynamics of the population growth (million people) in the second half of the 20th century (Brown, Kane *et al.*, 1994 in Agroecology, 2000).

Years	The whole world
1950	2555
1955	2779
1960	3038
1965	3345
1970	3704
1975	4086
1980	4457
1985	4856
1990	5295

The increase of population and food problem are interrelated. This problem is connected not only with the biosphere reserves but social and political problems as well.

Unfortunately the reserves of arable lands are decreasing, cultivation of new lands is rather difficult due to unfavorable climatic conditions and hard relief conditions.

In 1980s the decrease of the area of irrigated lands per capita was observed; from 0.053 ha in 1980 to 0.049 ha in 1990. The difference in the level of feed is very noticeable. More than 1 billion people live in extreme poverty, hundreds of millions are starving. Summary on food in different part of the world is in Table 3.

According to FAO data the increase of gross harvest of corn in the world till the middle of 1970s was by 75 percent due the grow of agricultural crop harvest and the expansion of sowing areas - by 25 percent. In the following years the growth of food production was conditioned by 90 percent, due to the growth of agricultural crop harvest and only by 10 percent due to the expansion of sowing areas. Although in 1950-1990 provision of corn per capita increased by 40 percent, in the following years it began to decrease. World stock of corn considerably decreased. This led to the price rise in the world market at the beginning of 1990s. As a result average food consumption per capita in the countries of Africa decreased by 17 percent, in Latin America - by 7 percent.

Table 3 Food in different parts of the world (Agroecology, 2000).

Region	Consumption per capita per day	
	Food stuff in whole	Protein, t
Asia	2244* 161**	55.3 9.6
Africa	2238 171	56.8 12.2
West Europe	3327 1042	95.2 51.8
USA	3514 1301	10.5 71.0
South America	2541 453	65.5 27.9

* - in numeral - total amount of food stuff and protein,
** - in denominator - the same of animal origin

At the conference of the UN dedicated to the issues of environment held in Rio-de-Janeiro in 1992 the representatives of 179 countries worked out "The agenda for the 21st century". It noted the necessity of the realization of two aims - high quality of the environment and strong economy for all the nations of the world.

By the year of 2000 annual increase of corn harvest made about 1 percent, it is supposed that in 2000-2030 more than 40 million ha land will be withdrawn from the agricultural turnover (3 % area under corn from the end by 1990s). In the countries of European economic community the reduction will make about 50 percent.

At the worldwide summit on the problems of food stuff (Rome, 1996) the participants noted that 800 million people in the world regularly are underfed. The problem of food stuff can still be solved. In China where population makes 22 percent of the entire population (more than 1.1 billion people) and the share of arable lands makes only 7 percent of the total arable land in the world the problem of food stuff is being reasonably solved. China occupies the first place for the gross production of wheat (100 million tons per year).

The population of the world is constantly increasing, hence the problem of food provision remains still urgent. Production of food-stuff in the world is permanently increasing though in many countries food provision is very poor.

Increasing number of population results in higher demand for food. The latter causes great anthropogenic influence on the nature and ecosystem.

The most ancient way of using natural resources on the earth is man's agricultural activities. Man tries to consume natural resources to a greater and greater extent. This is the only way to meet the increasing demand for food-stuff in the world. As a result man is violently disturbing ecological equilibrium of nature formed during millenniums. In the 20th century man's intrusion into nature became even more severe. The process of forest cuttings became more intensive, the area of ploughed lands increased, new gigantic hydrotechnical constructions started to appear at a higher rate, the amount of chemicals (fertilizers, pesticides) applied in plant growing increased, pastures were also greatly affected. As a result the process of degradation and pollution of soil cover has intensified. Man' s influence on nature and soil has turned into a global influence on the entire biosphere.

According to the data the production of food stuff per capita has increased. Though in many countries of the world hundreds of millions of people are underfed and hundreds of thousands die to hunger. At the conference of the UN dedicated to the environment and held 10 years ago it was noted that 1.1 billion people in the world earned less than 1 USD per day. The conference stated that the model of the national development of advanced countries was destructive for our planet.

In different parts of the world the living conditions of people varies considerably. The point is that historically formed soil and climatic zones and higher belts in the mountains possess diversified conditions for plant growing. To receive sufficient amount of food stuff basically depends on soil and climatic conditions.

The total area of the continents on our planet makes 14.8 billion ha, among them arable lands and perennial plants occupy 1.5 billion ha (about 11%), pastures - 3 billion ha (about 22.3%) and forest - nearly 4 billion ha (30%). The rest of the land - moors, sands, badlands, rocks, glacier, etc make 4.9 billion ha (36.6%). The above figures makes it possible to judge only general picture of land utilization. This picture varies on the continents and in the countries due to the different natural conditions and socio-economic systems of the countries. Though, the main changes in the structure of land utilization take place as a result of expanding farming activities by the increasing population of the world, growth of the number and size of cities and other populated areas. It has been stated that annual loss of arable lands in the world makes from 5-6 to -9 million ha. Their replenishment for agricultural needs is made mainly at the expense of forest cuttings and ploughing natural pastures.

To maintain life of one person on average requires 1.75-2.00 ha, among them 1.2 ha pastures and hay fields, 0.46 ha agricultural fields (to feed on), 0.07 ha forest (to absorb carbon and produce oxyden). Besides man needs different types of living accommodations and premises (0.01 ha), the infrastructure also takes 0.01 ha (roads, electric transmission lines, communication etc.)

On average 3 ha comes per capita in the world. Arable land per capita in the USA makes 0.7 ha, in Hungary - 0.5 hectares, in France and the Netherlands – 0.3 hectares each, in Russia - 11.5 hectares, in other countries of CIS - 3 ha. The effectiveness of use of every ha varies in different countries. For example,

in 1986 in India 16 tons of corn was received per 1 ton applied mineral fertilizers, in China and the USA - 18 tons of corn, while in the USSR - 8 tons.

In some countries of Western Europe the process of soil degradation has been due to balanced doses of organic and mineral fertilizers, against erosion and other soil protective measures (Kuznetsov and Glazunov, 1996).

As a result of human activities the growth of population causes the permanent increasing loss of arable lands. The most sensitive towards different types of anthropogenic influence proved to be weaker ecosystems in hot, arid and semiarid regions and farming territories in tundra, forest-tundra as well as in high mountainous zones with short vegetable periods. Hence, the most vulnerable soils are the following: arctic hums, cryptogenic, cryptopodzol, tundra mor-like glei, tundra eumulosol, high mountain, cinnamonic, grey-cinnamonic, grey-brown desert, reddish prairie, reddish-brown forest, reddish-brown (steppe), paved, humus calcareous, andosols etc.

The extent of influence on the natural ecosystems - ploughing new territories, erosion and deflation of soils, salinization, drying and pollution with chemicals (pesticides), soil compaction with heavy mechanisms while processing - is the same as other anthropogenic influence such as forest cuttings, pollution of atmosphere and oceans.

About 950 million hectares or one third of cultivated lands in the world is characterized by high salt concentration. Besides, 120-150 million hectares of irrigated land were salinized for the second time and deserted (Egypt, India, Iran, China, USA, Mexico). In the GIS half of the 20 million ha irrigated lands lost their fertility due to salinization. In African countries the loss of agricultural lands is in liniar dependence on the growth of population.

Salinization, erosion, degradation and exhaustion of soils lead to the increasing loss of the productivity of agricultural lands, which in many countries, particularly in developing ones (Mexico, Costa Rica, Mali, Malawi etc.) reach 0.5-1.5 percent of their annual gross national product.

Forest ecosystems occupy nearly 30 percent of land. Forest play essential role in the ecological equilibrium of biosphere as well as in the protection of soils and soils cover.

Total area of forests on the earth is more than 4 billion ha (among them 3 billion ha closed forests) (Table 4). More than half of them is tropical and subtropical forests. Forests grow on all the continents except Antarctica. Though, their distribution on our planet is not even.

According to the UN-ECE/FAO contribution to the Global Forest Resources Assessment (2000) average changes of the territory under the forests between 1990-2000 is shown in Table 5.

Table 4 Total data about forests in the World (Forest Resources, 2000).

Continents	Forest areas million ha		Timber resources billion m^3	
	Forest	Covered with forest	Total	Among them conifers
Euroasia	1,615	1,388	137	83.0
Africa	800	760	35	0.5
Australia	96	92	5	0.3
North America	750	630	59	40.0
South America	800	750	123	3.0
Whole world	4,061	3,620	359	126.8

Table 5 Average changes of the territory under forests.

Continent	Annual change (thousand ha)	Annual change rate (%)
Africa	-5,262	-0.78
Asia	-364	-0.07
Oceanic	-365	-0.18
Europe	+881	+0.08
North and Central America	-570	-0.10
South America	-3,711	-0.41
Total World	-9,391	-0.22

Forest area changes 1990-2000 in tropical and non-tropical natural forest (million ha y^{-1})

Domain	Net change
Tropical	-14.2
Non-tropical	+1.7
Global	+12.5

	1948	1963	1980	1990	2000
Global forest cover (in billion ha)	4.0	3.8	3.6	3.4	3.9*

*95 % - natural forest and 5 % - forest plantations.

The overall area of forest plantations increased by an average of 3.1 million hectares per year during the 1990s, including the 1,5 million hectares converted from natural forest and 1.6 million ha of afforestation on land previously under non-forest land use.

According UN-ECE/FAO contribution to the Global Forest Resources Assessment (2000): in Latin America, large scale direct conversion of forests dominates. It also dominates in Africa, but on a smaller scale. In Asia, the area of gradual conversions is equal to the direct conversions from forests to other land uses. At the global level, direct conversions dominate the picture, accounting for about three-quarters of the converted area. Most tropical

deforestation is thus a result of rapid; planned or large-scale conversion to other land uses, mainly agriculture.

Decrease of forest areas has several reasons: natural aridization and desertification (very few rains), rise of acidity of toxic matters of anthropogenic origin in air. The main reason is forest cuttings, using wood for heating, building, industrial raw materials etc.

The most urgent problem is the influence of technical progress on soils. Each year biosphere loses its active parts as well as territories with plants and soils producing biomass, and oxygen and turning carbon dioxide into biological nitrogen. The process of urbanization is also worth mentioning. In the middle of the 20th century there were 15 gigantic cities with the population 7-8 million people, 190 cities with about 1 million population and more than 25 million towns. Nowadays a new term "hyperurbanization" has entered the vocabulary. Big cities interflow. Superagglomerations and conurbanizations have already formed. In the near future the number of such huge cities will exceed 150.

A city is the most developed form of space organization. It is an industrial and social infrastructure with communication systems, wide range of professions, education etc.

As a result of urbanization it is impossible to meet biological demands of population. A city changes all the natural components - atmosphere, hydrosphere, soil climate, plants etc. In big cities physical conditions are deteriorated. Solar radiation is 15 percent less here, average wind speed decreases by 25 percent, the temperature is 1-5 percent higher etc.

In large cities medical and demographically indexes are considerably changed.

The following criteria (Table 6) are recommended for the estimation of ecological conditions of urban territories in the Russian Federation (Agroecology, 2000):

Any urban area is a source of great amount of industrial wastes (raw materials wastes, food production wastes) and consumption wastes (domestic wastes) (Table 7).

Table 6 Indexes and criteria recommended for estimation of ecological condition.

Indexes	Zone	
	Extreme ecological situation	Ecological disaster
Mortality growth	1.3-1.5 times	1.5 and more times
Infant diseases	1.3-1.5 times	1.5 and more times
Analogous diseases	1.5- 2 times	2 and more times
Genetic disturbance	about 3 times	3 and more times
Children with mental disorders	10 - 20 %	20 % and more

Table 7 Production of solid wastes in different countries (Agroecology, 2000).

Country	Per capita, kg	Total, 10^6 t
USA	744	178.0
Australia	681	10.0
Canada	635	16.0
Holland	449	6.5
Denmark	423	2.0
Switzerland	383	2.5
Great Britain	355	18.0
Japan	344	41.0
France	327	18.0
Germany	318	19.0
Sweden	317	2.5
Spain	275	10.5
Italy	263	15.0
Austria	228	1.7
Portugal	211	2.5

Both types of wastes are the main source of biotic, mechanic, chemical and other kinds of pollutants.

Among main types of wastes such as solid, liquid, gas and energetical, the significant place is occupied by solid domestic wastes.

Solid domestic wastes are dispersed negative factor, when moved away from urban areas they turn into a concentrated factor of negative influence on the nature.

In the cities with 1 million population after consuming 625 thousand tons of water, 2 thousand tons of food stuff and 9.5 thousand tons of fuel per day 950 tons of gas, 570 thousand tons of liquid and 2.5 thousand tons of solid wastes are formed.

Wastes occupying vast areas are the sources of soils first of all as well as atmosphere and water.

About 29 percent of refuse is burnt on the earth, more than 60 percent is dumped, 4 percent is composted and about 6 percent are processed differently (Table 8).

Another destructive factor causing the decrease of soil and biosphere fertility is desertification or aridization.

The primary form of aridization is high dryness, increase of surface runoff, deepened groundwaters. The following stage of aridization involves frequency of droughts, decreased precipitation, risen average temperature and others.

Table 8 Refuse utilization in different countries (Agroecology, 2000).

Country	Refuse share, %			
	burnt	dumped	composted	processes differently
USA	8.0	82.0	0.0	10
Great Britain	2.0	98.0	0.0	0
Canada	6.0	93.0	0.0	1
Denmark	32.0	64.0	4.0	0
Switzerland	80.0	18.0	2.0	0
Japan	72.0	24.5	1.5	2
Germany	28.0	69.0	2.0	1
Spain	5.0	76.0	19.0	0
France	36.0	47.0	8.0	9
Italy	18.5	35.0	5.5	41

Natural deserts are widely spread on the earth. Their total area varied during the Quaternary epoch having the tendency to increase. This is the process of natural desertification of former meadows, prairies, steppes, alluvial plains.

According Kovda (1997) the process of desertification involves considerable decrease of fertility of semiarid and subhumid landscapes to the level of desert fertility. The following processes also take place; changes in plant cover (substitution of species, plant sparseness and final disappearance of plant cover), animal world (changes in the composition and number of animals) and especially in soil cover (deflation, salinization, washing etc.).

Dry climate of desert is spread on 37 percent of land, while actual area of desertic soils and plants reaches 43 percent. On about 6 percent of land area (more than 9 million km^2) temporary soil and plant conditioned do not coincide with the climatic ones and all this has an anthropogenic nature. Besides, there are also areas of partial desertification. High speed of desertification is observes along the south border of Sahara Desert.

It was proved long ago (Pabot, 1960; Kassac, 1970), that all the deserts of the Near East are manmade. Vast territories in the Lebanon, Syria, Egypt, Tunisia were under plant cover 2-3 milleniums ago but now they are semideserts and deserts. Destruction of plant cover in semiarid and arid regions is the result of its use not only for cattle but for heating as well. It has been stated that in arid zones of the world about 1.5 billion heads of cattle graze. This cattle grazes in extremely weak and unsteady ecosystems of the world. The major way out is to regulate the process of grazing.

In particular arid zones do not occupy vast territories, but they are areas with permanent possibility of droughts, for example 10-15 percent (i.e. 10-15 years per century). If we consider them as the areas with variable aridization then the total area together with the zones of stable aridization will make 50-60 percent of land. The number of countries interested in the solution of the aridization problem reaches 70-80. Historic tendency of desertification is well observed on the example of the climatic history of North America (Darrow, 1961) (Figure 2).

On this continent from the end of the tertiary period and especially in pleistocene and holocene the territories occupied by deserts and semideserts, savannas and steppes considerably increases. Moreover, it is believed that in various period the level of aridity was even more than now.

It has been stated that in the third millenium B.C. the borders of the Arctic and Subarctic were much more northern.

Besides powerful anthropogenic factor, land aridization, according to V.Kovda (1977), is also influenced by natural factors: 1) progressive decrease of groundwater level, 2) slow general tectonic rise of plains, 3) the increase of draining role of rivers, 4) the rise of borders of permanent snows in mountains. According to the National Academy of the USA (1985) the variation of average annual precipitation has a negative influence on land. (Figure 3).

The process of aridization encourages intensive use of ground waters for domestic, industrial and transport needs.

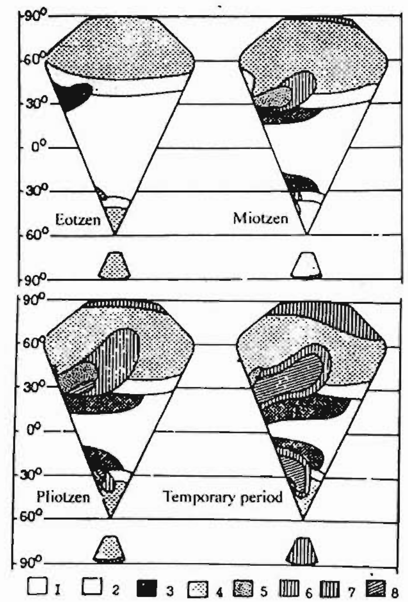
The process of aridization is facilitated by dust storm the number of which is rising catastrophically. In the 18th century the number of dust storms was 7 times as more than in the 17th century, while in the 19th century it was 3 times a more than in the 18th. Such an intensive growth of dust storms is closely linked with the disappearance of plantations. Wind erosion causes the complete destruction of soil cover or its more fertile higher horizons.

Arid zone soils are relict soils. Their absolute majority was formed in different natural conditions - as a result they are not stable and their equilibrium is very conditional. They are easily influenced by anthropogenic factors and are easily destroyed.

Another serious problem is the problem of secondary salinization of soils. This is the problem facing the Near East and the Middle East, Middle Asia, Transcaucasus, Latin America, North America. It can be explained by absence of draining or poor drainage systems, poor quality of irrigation waters etc.

Soil is a complicated system. Its main functional components are living organisms.

Soil cover is an independent component of the earth - the pedosphere. Soil is the product of the joint influence of climate, plants, animals, microorganisms on geological species. Complicated process of synthesis and destruction of organic substances as well as circulation of different elements, decomposition of injurious substances, etc take place in soils. The following phases are interrelated in soils solid, liquid, gas and organic.



1 – subtropical forest; 2 – forest of moderate warm climate
3 – subtropical savana; 4 – forest of moderate climate; 5 – dry forest
6 – grasses; 7 – polar and subpolar zone; 8 – desert

Figure 2 The changes of the main species of vegetation (Darrow, 1961).

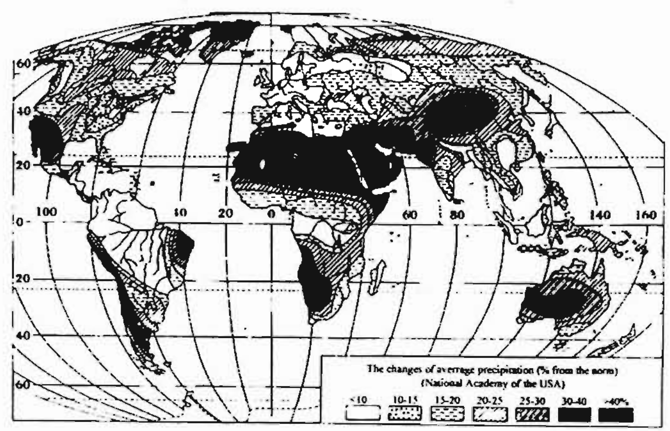


Figure 3 The changes of average precipitation (% from norm) (National Academy of the USA).

The major function of soils is to provide life on the earth. Realization of this function depends on the composition of chemicals in soils in available forms. Essential biogenes (carbon, nitrogen, phosphorus, potassium, calcium etc.) are involved in soils.

Soil regulates the flow of substances in the biosphere. It also regulates biological and geological circulation of elements in the biosphere.

The most significant global function of soils is to accumulate in the upper part mantle of waste connected with it with the chemical energy.

Soil is essential in agriculture and is a basis of agroecosystems. Soils provide mankind with about 95 percent of all the food stuff. Soil is a living space giving life to different living organisms.

Soil is a mechanic basis of all the plantations growing on it.

Analyzing the importance of soils in eco- and agroecosystems it is also worth mentioning that its abilities are limited. Soil functions can be violated by man's activity (Table 9). One example of this is soil sickness. Such soils do not provide effective agricultural harvest. This is the result of permanent cultivation of the same crop on one and the same area. In such cases different toxic substances are accumulated in soils. These substances are secreted from the plant roots and microorganisms.

Total area of soils exposed to destruction and degradation during the whole history of mankind makes 20 million km^2. This is more than total area of temporary arable soils of the world 0 15 million km^2. At the UN Conference on the Environment and its development the participants noted that the extreme degradation of soils was observed on 1 percent area, strong - 15 percent, moderate - 46 percent and weak - 38 percent. Degradation of soils is caused by water erosion by 56 percent, 28 percent - by wind erosion, 12 percent - by chemical degradation and 4 percent - by physical degradation. The X1X special session of the General Assembly of the UNO (June 1997) adopted the program for further activities to realize "The agenda for the 21^{st} century". This program involves sustainable use and protection of lands.

Deterioration of soils resources and decreasing fertility of soils threaten the lives of millions of people and food safety in future as well as water resources and maintenance of biological diversity.

Heavy metals are main pollutants from the view of the pollution extent and influence on biological elements. Many of them are necessary for living organisms, though as a result of intensive atmospheric dispersion in the biosphere and considerable accumulation in soils heavy metals become toxic (Tables 10 and 11).

Table 9 Ecological consequences of anthropogenic changes in soils (Rozanov and Rozanov, 1990).

Anthropogenic influence	Soil degradation processes
Agriculture on border areas of different landscapes	Erosion, deflation, dehumification
Irrigated agriculture in arid and semiarid zones	Swamping, salinization, alkalinisation
Irrigated agriculture in subhumid conditions	Destructurization, alkalinisation, soil compactness
Non-balanced (irregular) application of chemical fertilizers	Increase of acidity, chemical pollution of soils, dehumification
Application of biocides in agriculture	Chemical pollution
Agricultural mechanization	Heavy compactness of soils, erosion
Pasture livestock breeding with irregular grazing	Erosion, deflation, dehumification (humification)
Intensive stall livestock breeding	Chemical pollution, decomposition of plant and animal wastes in the conditions of oxygen shortage and secretion of methane
Forest cuttings on plains	Swamping, dehumification
Forest cuttings in mountains	Erosion
Operations at the place of oil origin	Soil pollution by oil products
Operation at the place of mineral origin	Physical destruction of soils, chemical pollution
Thermoenergetics	Chemical pollution, rise of acidity
Transport	Soil destruction, chemical and oil pollution
Metallurgy	Chemical pollution, rise of acidity
Chemical industry	Chemical pollution, rise of acidity
Building material production	Chemical pollution
Urbanization	Chemical pollution
Surplus agriculture on arid areas	Complex degradation

At the beginning of 1990s total annual amount of heavy metals in atmosphere caused by different industrial activities in North America and Europe made: lead 370 thousand tons (among them due to etiolated petrol - 280 thousand tons), arsenic - 31.2 thousand tons (ferrous and non-ferrous metal industries, glass production, cement production), cadmium - 7.6 thousand tons (non-ferrous metal industry 6.2 thousand tons) etc. In non-ferrous metal industry while producing 1 ton production 40-60 kg lead, about 3 kg arsenic, about 280 g mercury and 13 g cadmium is dispersed in the atmosphere.

Table 10 Average content of heavy metals in soils in back ground areas of the world, mg kg^{-1} (Monitoring of Back Ground Pollution of the Environment, 1986).

Region	Lead	Cadmium	Arsenic	Mercury
West Europe	3.8-80 (16)*	0.01-1.4 (0.22)	0.10-11 (2)	0.001-3.0 (0.07)
European part of the CIS	2.8-38 (13)	0.01-0.97 (0.28)	0.8-8.6 (2)	0.025-0.32 (0.11)
Asia (without Russia)	3.0-40 (14)	0.04-0.40 (0.12)	3.5-12 (7)	0.040-0.33 (0.11)
Asian territory	2.5-38 (16)	0.028-3.2 (0.26)	0.5-7.3 (3.8)	0.004-0.018 (0.01)
North America	5.2-73 (17)	0.05-0.56 (0.19)	1.0-7.5 (4.1)	0.002-0.16 (0.02)
North Afririca	3.0-24 (15)	-	-	-
South Afririca	1.1-71 (18)	0.08-0.81 (0.25)	-	-
Australia, New Zealand	14-20 (16)	0.15-0.20 (0.17)	-	-
Average content in world soils(according to various authors)	(16)	(0.21)	(2.9)	(0.04)
	(10)	(0.50)	(5.0)	(0.01)
	(12)	(0.35)	(6.0)	(0.06)
	(20)	(0.08)	-	(0.04)
	(10)	(0.50)	(10)	(0.10)
	(29)	(0.62)	(11)	(0.098)

* - average significance

Table 11 Estimation of agricultural soils according to the extent of pollution by chemicals (State Committee for Nature, USSR, 1990).

Soil categories	Characteristics of polluted soils	Possible use
Permissible pollution	Content of chemicals exceeds back ground, but not MPC (maximum permissible concentration)	Under any crops
Moderate dangerous pollution	Content of chemicals slightly exceeds MPC	Under any crops as long as the quality of agricultural products is controlled
Heavy dangerous pollution	Content of chemicals considerably exceeds MPC according to main indexes	Under industrial crops without using them for food stuff or forage
Extremely dangerous pollution	Content of chemicals exceeds MPC according to all the indexes	Not for agricultural needs

Heavy metals play important role in exchange processes, though they cause heavy pollution of soils and have negative influence on ecosystem.

Heavy metals do not easily excrete from soils. Period of semiexcretion is for Zn - 70-510 years, Cd - 13-1100 years, Cu - 310-1500 years and Pb - 740-5900 years.

Heavy metals undergo chemical changes in soils. Hence they become even more toxic.

Heavy metal mobility in soils depends on the content of organic matters, soil acidity etc.

Among toxic substances of anthropogenic origin dioxines are the most dangerous. Dioxines are as threatening to mankind as a nuclear weapon. The period of semidecay of dioxines in soils is about 10 years, in water - 1-2 years. Dioxines are mainly situated in soils at depth of 5-10 cm. Dioxines actually do not excrete from a human organism.

Even in small concentration dioxines cause immunity depression and violate the ability of adaptation in organisms.

Nowadays there are very strict norms of dioxine composition. Daily consumption of dioxines must not exceed 0.1 pg kg^{-1} (1 pg=10^{-12} g)

In Germany dioxine concentration on pastures must not exceed 5 ng kg^{-1} soil, in the Netherlands and Italy - 10, in the USA - 27 ng kg^{-1} soil (1 ng = 10^{-9} g).

Field fertilization has practiced since long ago. Fertilizers were of great importance even in Ancient Rome in the 1st century A.D.

According to the US experts the influence of different factors on the yields of agricultural crops on estimated the following way (%):

Fertilizers	41
Herbicides	15 - 20
Favourable soils	15
Hybrid seeds	8
Irrigation	5
Other factors	11-16

Nowadays every fourth citizen of our planet is provided with the food received with the help of fertilizers.

Wrong application of fertilizers is a very negative factor. Application of organic and mineral fertilizers with other agrotechnical and biological fertilizers is a reliable basis for high fertility of soils without any harm to nature.

Soils as the most significant component of biosphere undergo the following tendencies of changes: almost everywhere soils are destroyed and fertility is decreased. Inhabited areas, roads, storing areas etc. occupy about 2 billion hectares. About 40-60 percent of arable lands and pastures are eroded and deflated annually. About 40 percent of irrigated soils are salinized. Bioenergetic resources in soils are decreased (low humus content), soil fauna and microorganisms die out (soil sterilization). Toxic biocides and surplus fertilizers are accumulated. Soil acidulation is a wide-spread process (acid rain).

This brief review of soils and soil cover shows that in the 21st century no natural drastic changes of soils in time and space are expected. But anthropogenic changes of soils may be intensive. This process is extremely negative today and beyond our control. Decisive measures must be taken in this direction.

The first stage - The world database on the conditions of soils and soil cover must be created. World soil scientists must understand one another. In this connection new world classification of soils (WRB classification) must be spread in many different countries. The experience of its spread turned to be very effective. One can cite as on example the new Soil Map of Georgia (1999).

The second stage - To systemize world experience of soil protection and their rational use.

The third stage - To organize effective worldwide monitoring of soils and soil cover.

The future of our soils - the main riches of mankind - depends on effective and prompt solution of the above problems.

Time flies.

We must hurry.

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BLUM Winfried E.H.
Secretary-General of IUSS,
Institute of Soil Research at the University of Agricultural Sciences, Vienna, Austria

Soils belong, besides air and water, to the most important environmental assets for sustainable development, but the functions of soils for sustaining society and the environment are not well understood, neither by the broad public, nor by politics and decision making. However, there are clear signs that soils are becoming increasingly important in national and international discussions. The World Conference on Sustainable Development (WCSD) in Johannesburg, August /September 2002 has soil issues included in its agenda. Moreover, in the European Union, a new soil initiative has been proclaimed, which shows that in this region of the world soils are becoming an important social, economic and environmental target.

All this indicates that after many years of struggle, soils are now in the focus of environmental concern and sustainable development and will therefore become an issue for international research and development.

The 17[th] World Congress of Soil Science will contribute to designing new important goals in this respect.

The role of soils in sustaining society and the environment: realities and challenges for the 21st century

BLUM Winfried E.H.

Secretary-General of IUSS, Institute of Soil Research, University of Agricultural Sciences, Vienna, Austria

SUMMARY

The main functions of soils for sustaining society and the environment and actual problems in soil and land use on a worldwide level are discussed, which can be explained by the temporal and spatial competition in the use of these functions

Based on this analysis, challenges for soil sciences in the 21st century are identified, distinguishing between challenges to science and research on one side and the bridging between soil science and and the civil society on the other side.

Keywords: soil functions, better understanding of soils, soil remediation techniques, new concept of soil sciences, soil basic research

The Role of Soils in Sustaining Society and the Environment

The role of soils in sustaining society and the environment is complex and research findings are constantly contributing new insights into soil functions, which can be classified in many different ways. In a comprehensive approach, six main functions can be distinguished, three of them more ecological ones and three others more related to cultural, social, economic and technical issues.

Soils do not only serve for agriculture and forestry, producing biomass, but also for filtering, buffering and transformation activities between the atmosphere and the ground water, protecting the food chain and drinking water against pollution and maintaining biodiversity. Regarding the latter, soil is the most important gene reserve, containing more biota in species diversity and quantity than all other above ground biomass on the globe.

These three ecological functions are in constant competition with the use of soils for the development of technical infrastructures, such as the establishment of industrial premises, houses, ways of transport, dumping of refuse, installation of recreation facilities, and other processes through which soils are sealed and for which we use soil as a source of raw materials, such as clay, sand, gravel and mineral materials in general. Moreover, soil is a memory and therefore a geogenic and cultural heritage, concealing and protecting paleontological and archaeological treasures, for the understanding of our own history and that of the earth (Blum, 1998a, b).

Not all these six functions are used concomitantly on the same site and at the same time, even though an intensive competition in the different land and soil uses can be distinguished, which is the main problem for sustainable land use.

Realities

Therefore reality is characterized by a fierce temporal and spatial competition in the use of the above mentioned six different soil functions. The way in which competition occurs can be classified in three categories: exclusive competition between the use of land for the development of infrastructure, as a source of raw materials, and as a geogenic and cultural heritage on one side, and agricultural and forest production, filtering, buffering, and transformation activities, as well as the soil as a gene reserve on the other side. The best example for this is the sealing of soils through infrastructural development, which can be seen in the sealing of land for transport networks and urban and industrial agglomerations (Figure 1).

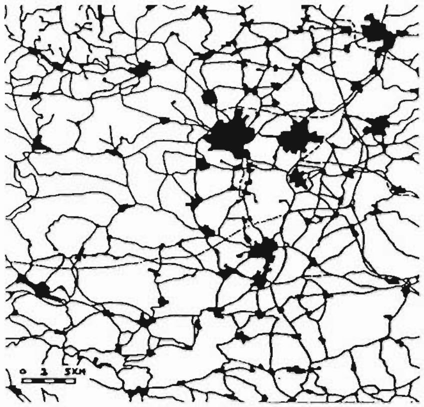

Figure1 Sealing of soils by settlements and transport networks (observe the scale).

A second form of competition is the intensive interaction between infrastructural land use and its development on one side and agriculture and forestry, filtering, buffering and transformation activities, as well as soil as a gene reserve on the other side, because all the urban and industrial agglomerations and ways of transport put heavy loads into the adjacent agricultural and forest soils on the atmospheric and water pathways and through terrestrial transport, mainly due to an excessive use of fossil energy and raw materials, through traffic and transport, industrial, housing and other human activities (Blum, 1998c, Figure 2). In this context it seems important to underline that soils are the most important sink within environmental media (Crosby, 1982, Table 1). Moreover, physical impacts on soils occur through

infrastructural development causing compaction and high surface runoff, with subsequent erosion (Camarda and Grassini, 2001).

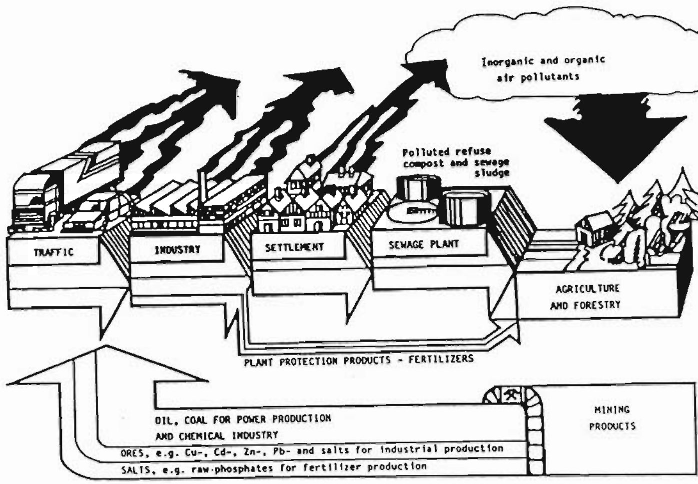

Figure 2 Loads on agricultural and forest soils through the use of fossil energy and raw materials.

Table 1 Theoretical pollutant distribution in the environment at equilibrium (Crosby, 1982).

Compartment	Z[1]	Concentration[2] (mol m^{-3})	% distribution in compartment
Air	40	$4x10^{-10}$	0.35
Water	10^4	10^{-7}	0.01
Sediment	10^9	10^{-2}	9.1
Soil	10^9	10^{-2}	90.5
Aquatic biota	10^4	10^{-7}	0.01

[1] Fugacity capacity can be regarded as the "ecaping tendenca" of a chemical substance from a phase: it has units of pressure and is linearla proportionl to concentration (at least at most low concentrations of environmental interest) (MacKay, 1979)

[2] Assumes approximately 100 kg of pollutant (MW 100) introduced into 10 km3 of the environment.

Looking only into the different chemical pathways and processes, pollution by inorganic and organic compounds along traffic routes and in the vicinity of industrial premises and urban agglomerations can be seen, the latter being aused by the accumulation of goods and materials within these agglomerations, ich are again redistributed by different processes in their near vicinity, often in high concentrations. In this sense, urban and industrial agglomerations are chemical time bombs (Blum, 1998c, Figures 3, 4, 5 and 6). Figure 3 indicates the deposition of pollutants near traffic routes. Figure 4 shows the flow of goods in tons per day through the city of Vienna, an administrative city almost without industry, with about 1.6 million inhabitants, showing that even less industrialized cities have an enormous daily turnover rate and flow of goods.

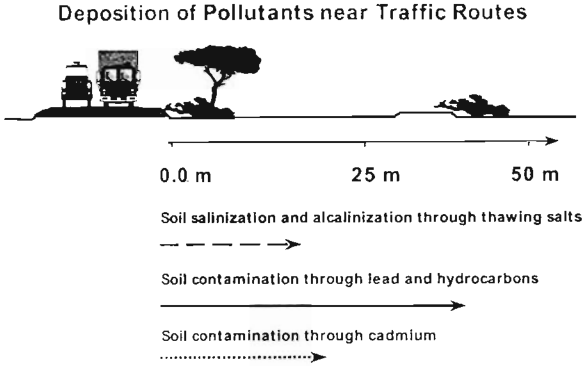

Figure 3 Deposition of pollutants near traffic routes.

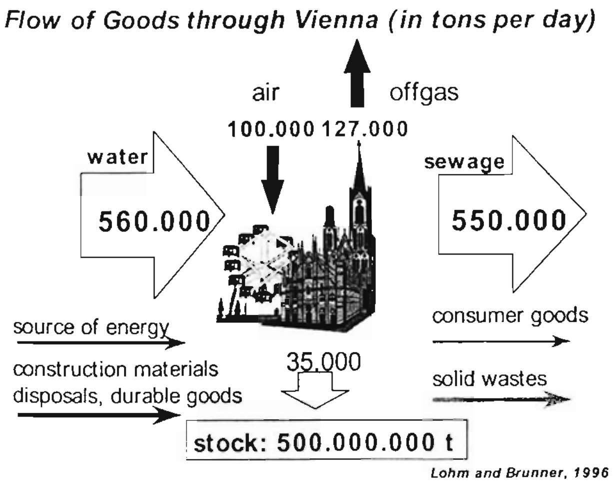

Figure 4 Flow of goods through Vienna (in tons per day).

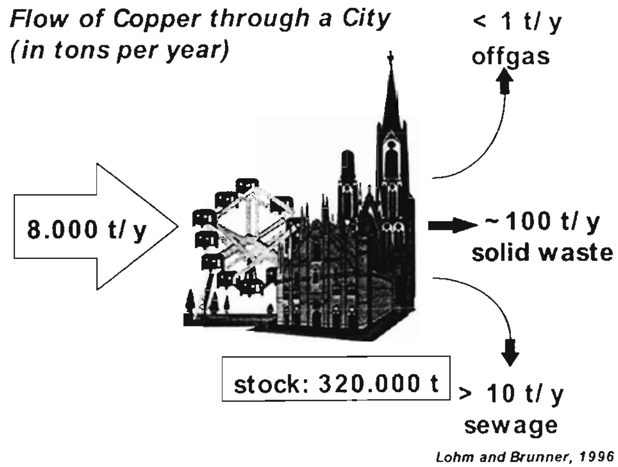

Figure 5 Flow of copper through a city (in tons per year).

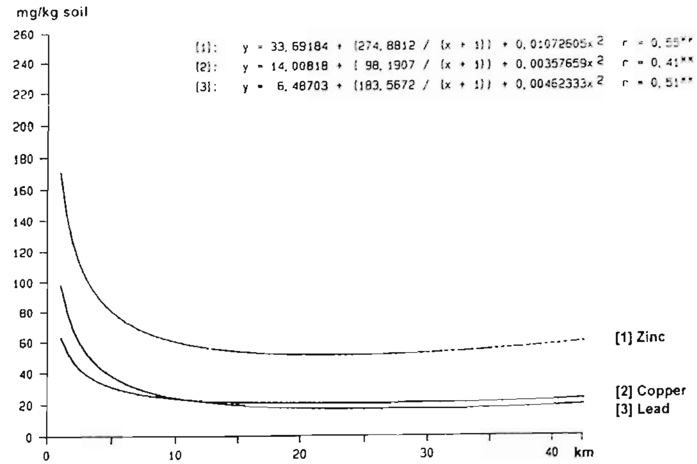

Figure 6 Changes of heavy metal content in topsoils (0-20 cm) between metropolitan Vienna (Reichsbruecke) and the eastern state border (Koechl, 1987).

Figure 5 shows the mass flow of copper in a city, in tons per year, indicating that only small amounts are leaving the city and are distributed in the vicinity, whereas the rest remains in the city and is accumulated with time. It is difficult to foresee what will happen with this copper in the long run. The distribution of copper in the vicinity of Vienna can be seen in Figure 6, showing the concentration in the top soil (0-20 cm depth) in a distance of about 40 km from the city center, clearly showing an exponential decrease of this element from the city centre towards more distant areas.

From these and other data, it can be concluded that the flow of goods is one of the main driving forces behind soil contamination and pollution. Whereas in industrialized countries legal instruments are increasingly controlling the flow of goods through industrial agglomerations, it becomes more and more difficult to do the same with the individual use of goods, e.g. batteries, modern electronic equipment and others, e.g. in large urban agglomerations. Here, new challenges lie ahead. In contrast, in developing countries, very few industrial emissions are really under control and therefore the main contamination of land and soil is still mainly caused by industrial activities.

The third competition occurs between the ecological uses themselves, through the competition between biomass production on one side and the production of ground water and the maintenance of biodiversity, on the other side. This becomes evident from the fact that farmers produce biomass on top of their soil, but at the same time ground water underneath, because each drop of rain falling on their land has to pass through their soil before it becomes ground water. The same is true for the maintenance of biodiversity, because monocultures and the use of chemical inputs reduce biodiversity to a great extent (Figure 7). Moreover, agricultural land use is one of the main causes of soil erosion and compaction due to the physical management of soils (Bridges *et al.*, 2001).

Based on this approach, sustainable use of land and soil for sustaining society and the environment can be defined as the spatial and/or temporal harmonization of all these main uses of soil and land, excluding or minimizing irreversible ones, such as sealing, excavation, erosion, sedimentation, contamination or pollution, salinization, alcalinization and others. This definition includes the dimension of space and time, whereby irreversibility is defined by a time interval of 100 years, which means that impacts which cannot be leveled out by natural processes or by human interference within 100 years should be considered as irreversible (Blum, 1998d).

Harmonization is not primarily a scientific, but a political target. Science can only contribute through the development of scenarios, decisions are taken by politics. However, the question remains, how to bridge between scientific and technological knowledge on one side and politics and decision making on the other side. Even for science it becomes more and more difficult to analyze the complexity of the land and soil systems and the many interactions occurring in

them because of the increasing specialization in scientific education, training and research.

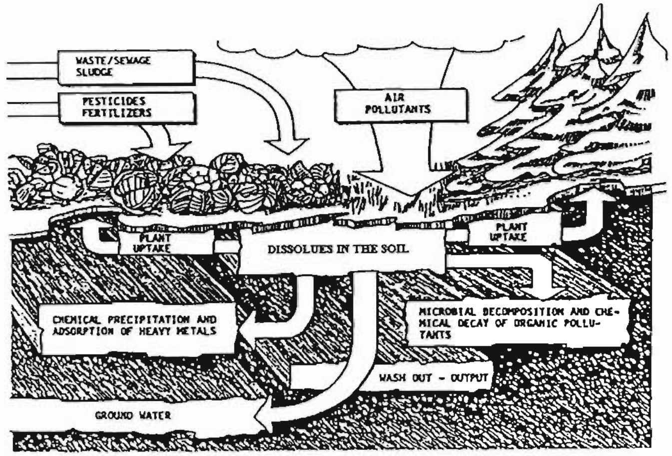

Figure 7 Competition between agriculture and forestry on one side and the protection of groundwater, surfacewater and the biodiversity on the other side (compare to Figure 2).

How can soil sciences address those complex issues or, more generally, what are the challenges for soil sciences in sustaining society and the environment in the 21st century?

Challenges for Soil Sciences in the 21st Century

Challenges for soil sciences are twofold. On one side science has to analyze and to evaluate the processes and changes occurring in human societies and the environment. On the other side, science has to bring this knowledge to those who need it for decision making and politics.

In the following, the two different challenges will be discussed in more detail.

Scientific-technical challenges:

These challenges can be classified in three different categories, which correspond to the new scientific structure of IUSS (IUSS, 2000):

- understanding of soil in space and time;
- understanding of soil properties and processes;
- understanding of soil use and management and its benefits for human society.

Better understanding of soil in space and time:

Each natural science dealing with concrete subjects which can be grasped by one's hands or seen by one's eyes, starts by investigating their outer appearance, in our case by soil morphology. We are still far from understanding soil morphology and its specific characteristics in time and space, leading to a distinct insight into their geographical distribution and finally to their classification in a comprehensive system. The understanding of the geographical distribution of soil covers and the subsequent adaptation and development of soil classification systems is a continuous challenge, which fortunately becomes more and more visible through the World Reference Base of Soil Resources (WRB), through which we can define our object of scientific research on a global level (WRB Working Group, 1998).

How can a science be understood, if it is not able to define its own subject of research by a sound taxonomic system? One of the biggest problems in the relation between soil science and other natural and engineering sciences is that soil taxonomy and classification is difficult to understand, because its rationale is rarely available in a written form but mostly through oral transfer. Without the development of a more user-friendly soil classification system, which helps to define quickly and without great efforts the object of soil research, (e.g. on a soil type or sub-type level), soil science will lose further terrain in the future. Therefore, new efforts will be necessary in order to develop and to improve the soil classification systems on a global, regional and local level (Blum and Laker, 2001, Eswaran *et al.*, 2001).

Paleopedology can be helpful for better understanding historical soil development and soil classification. Moreover, paleopedology could be an important bridge between soil science and archaeology (Fuelecky, 2001; Collins *et al.*, 1995 Scudder *et al.*, 1996).

Better understanding of soil properties and processes

For understanding soil as a complex system, soil physics, soil chemistry, soil biology, soil mineralogy, macro- and micropedology as well as pedometrics must closely co-operate. This becomes evident from the simple fact that physical, chemical and biological processes in soils occur mainly in the pore space, which means that liquids, gases or biota within the pores react among themselves and with the constituents of the pore walls, such as minerals (e.g. clay minerals, oxides), or humic substances (Blum, 2002, Figure 8).

Moreover, biota, especially microorganisms are always and everywhere present in soils. They may play a more important role in soil physical, chemical and mineralogical processes than considered so far, especially in the energy dependent processes of electron transfer (Huang *et al.*, 1995, 2002).

The methodological basis of all these disciplines was not developed by soil science, but by basic natural sciences such as physics, chemistry, mineralogy, biology and by mathematics and statistics. Therefore, soil disciplines can only develop further if they co-operate closely with basic natural and other sciences.

For this, the full membership of the International Union of Soil Sciences (IUSS) in the International Council for Science (ICSU) provides excellent opportunities. Table 2 lists the 26 international unions, among them many that could be partners of soil sciences (ICSU, 2000/2001).

Better understanding of soil use and management

One of the most challenging problems is the world-wide sealing of soils by urban and industrial growth, which is still unprecedented, and will lead to enormous constraints in many densely populated areas, in the very near future. Moreover, in countries, which do not dispose of rock material for construction purposes because their underground only contains river sediments, e.g. Bangladesh, soil mining for the production of bricks causes severe losses of fertile agricultural land.

In the field of sustainable use and management of soils, agricultural soil fertilizing and plant nutrition is of great importance for feeding increasing human populations. In this field, better understanding of rhizosphere processes is one of the most important issues, because they are the key for understanding soil-plant relationships, for improving plant growth and for maintaining or improving soil fertility. This scientific target is not new, but in recent years new tools in soil chemistry and physics, plant physiology, microbiology, biochemistry and gene technology became available, fostering new research (Pinton *et al.*, 2001; Tinker and Nye, 2000).

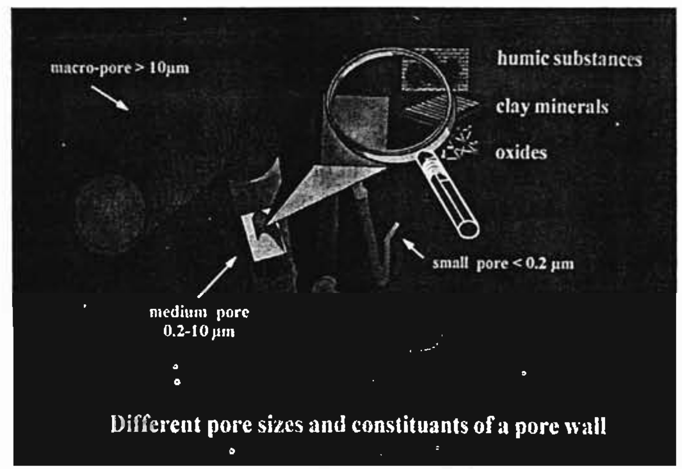

Figure 8 Different pore sizes and constituants of a pore wall.

Table 2 Scientific Union Members of the International Council for Science (ICSU).

Scientific Union Members of the International Council for Science (ICSU)
International Union of Anthropological and Ethnological Sciences **(IUAES)**
International Astronomical Union **(IAU)**
International Union of Biochemistry and Molecular Biology **(IUBMB)**
International Union of Biological Sciences **(IUBS)**
International Union of Pure and Applied Biophysics **(IUPAB)**
International Brain Research Organization**(IBRO)**
International Union of Pure and Applied Chemistry **(IUPAC)**
International Union of Crystallography**(IUCr)**
International Union of Food Science and Technology **(IUFoST)**
International Union of Geodesy and Geophysics **(IUGG)**
International Geographical Union **(IGU)**
International Union of Geological Sciences **(IUGS)**
International Union of the History and Philosophy of Science **(IUHPS)**
International Union of Immunological Societies **(IUIS)**
International Mathematical Union **(IMU)**
International Union of Theoretical and Applied Mechanics **(IUTAM)**
International Union of Microbiological Societies **(IUMS)**
International Union of Nutritional Sciences **(IUNS)**
International Union of Pharmacology **(IUPHAR)**
International Union of Pure and Applied Physics **(IUPAP)**
International Union of Physiological Sciences **(IUPS)**
International Union of Psychological Science **(IUPsyS)**
Union Radio Scientifique International **(URSI)**
International Union of Soil Sciences **(IUSS)**
International Union of Toxicology **(IUTOX)**

Also in the field of new biotechnologies, especially gene technologies, new horizons become visible, e.g. in the field of soil microbiology (Hugenholtz et al. 1998; Moran *et al.*, 1993). Looking at the use of genetically modified plants in agriculture, the question about gene transfer within the soil arises. Our knowledge in this field is still insufficient.

New research findings about endocrine disruptors, e.g. Nonylphenol and Ethoxylates in soils, mainly caused by the spreading of pesticides and refuse materials, e.g. sewage sludge, show that these are very persistent and therefore constitute a long term ecotoxicologial risk (Gerzabek and Haberhauer, 2002; Kvalock, 1996).

Another emerging challenge is the substitution of rock phosphates within the next decades, because these will then no longer be available, or only in a much inferior quality, and long before that they will become so expensive that they will scarcely be available for agriculture. Therefore, we should start now looking for other P-sources, e.g. through P-recycling.

In the field of soil and water conservation, the competition between agricultural land use and ground water protection has to be controlled.

Therefore, fertilizers, pesticides and other inputs for the improvement of soil fertility and plant growth have to be dosed in relation to the overall environmental demands. In this context, soil evaluation is very important (Lal *et al.*, 1998; Lyman *et al.*, 1982; Zehnder, 1995).

Other problems will emerge because of the use of new soil technologies, causing deep reaching compactions (Horn *et al.*, 2000).

As forests, in contrast to agricultural areas, are filtering gases, dust and aerosols out of the atmosphere, the protection and management of forest soils becomes increasingly important, due to soil acidification and contamination and the subsequent mobilization and leaching of elements, especially aluminium and heavy metals, endangering drinking water resources (Szabolcs, 1989; Ulrich and Sumner, 1991).

Another problem for human societies is the remediation of contaminated sites and soils by physico-chemical approaches or by bioremediation techniques (Adriano et al. 1999). A core question in this context is the time scale of bioavailability of toxic compounds, e.g. heavy metals. We still do not fully understand the mechanisms behind the binding or fixation of those elements by soil constituents, thus reducing bioavailability with time. In the area of remediation, soil scientists are often not sufficiently involved, because engineers have taken the lead. Therefore, more co-operation between soil sciences and engineering sciences is needed.

Cultural, societal and economic challenges

Cultural, social, and economic features of soils are becoming more and more important on a local, regional and global level (Karlen *et al.*, 1997).

Our traditional way of looking at soils mainly as a substrate for agricultural or forest production has greatly changed due to new ecological concepts and insights (Lubchenco, 1998). Soil issues are playing an increasing role in international conventions, such as the UN Framework Convention on Climate Change (UNFCCC, 1992), because soils have sink and source functions for CO_2 and store three times more organic carbon than the above ground biomass and two times more than the atmosphere (Lal *et al.*, 2000). Therefore, the Kyoto Protocol and other developments in the legal framework of environmental protection implicate new challenges for soil science in international co-operation with other sciences, especially in the field of carbon sequestration (UNFCCC, 1998).

The UN Convention on Biological Diversity (UNCBD, 1992) also includes an important soil component, because there exist by far more biota in number of species and quantity in the soil than above it. They are highly endangered by physical and chemical soil degradation. Therefore, soil biology should strongly cooperate in research for biodiversity and the maintenance of biota in terrestrial and related ecosystems on a world-wide level. The UN Convention to Combat Desertification, (UNCCD, 1992) challenges soil sciences through its responsibility to find ways against soil degradation in arid, semi-arid and dry semi-humid areas. It is the only world-wide convention directed towards land and soil protection, although in a climatically restricted approach, see Table 3. Therefore soil sciences should co-operate more closely in the field of international environmental protection (Tutzing, 1998; Blum, 2001b).

Another emerging issue is soil and human health. There exist many relations between soil and human and environmental toxicology, especially in the sphere of soil biology, and chemistry, which are not yet well understood, but very important for the well-being of human societies, as outlined above. Today, in many regions of the world, soil and environmental toxicology gain the same importance as food production, or even more, and therefore become an increasingly important factor (Oliver, 1997; Deckers *et al.*, 2000).

Soil and food security, especially under the aspects of sustainable food production (availability and accessibility), remain important problems, which are far from being solved in many areas, where hunger still is an important threat.

In conclusion, it can be stated that new ideas and concepts in soil sciences are needed in order to promote interdisciplinary research for environmental protection and sustainable land use. "Novelties come from previously unseen associations of old materials. To create is to recombine" (Francois Jacob, in: Keinan and Schechter, 2001).

Finally it can be stated that all these targets cannot be reached in the medium or long run, if soil sciences are not promoting the teaching of soil issues at the primary and secondary school levels, in order to improve knowledge about soils, thus raising interest for soil scientific research. In this context, a revision of soil teaching curricula at university level seems to be important as well. Finally, more knowledge about the history of soil science could help to improve our integration into the scientific community and our acceptance by the public (Yaalon and Berkowicz, 1997).

In the latter context, the evaluation of soils and the use of indicators for sustainable soil and land use is a task which should be better understood by the soil science community (Blum, 1999, 2001a; German Advisory Council on Global Change, 1995). The approach of the OECD (1997) to identify agri-environmental indicators within a defined framework of a driving force-state-response relationship for an environmentally safer agriculture (Figure 9) was improved by the European Environment Agency (EEA), extending the OECD approach to a more comprehensive framework, called DPSIR (EEA, 1999). This approach includes driving forces, and pressures deriving from them, causing a state, which itself creates impacts, which further need responses for alleviation and mitigation (Figure 10). These frameworks aim at bridging between science and policy, promoting a better steering of complex terrestrial and aquatic ecosystems.

Table 3 Core environmental conventions and related agreements of global significance.

MEA	Date adopted	Secretariat
1) Atmosphere Conventions:		
1. United Nations Framework Convention on Climate Change (UNFCCC)	1992	UN
2. Kyoto Protocol to the United Nations Framework Convention on Climate Change	1997	UN
3. Vienna Convention for the Protection of the Ozone Layer	1985	UNEP
4. Montreal Protocol on Substances that Deplete the Ozone Layer	1987	UNEP
2) Biodiversity-related Conventions:		
5. Convention on Biological Diversity (UNCBD)	1992	UNEP
6. Cartagena Protocol on Biosafety to the Convention on Biological Diversity	2001	UNEP
7. Convention on International Trade in Endangered Species (CITES)	1973	UNEP
8. Convention on Migratory Species (CMS)	1979	UNEP
9. Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA)[1]	1995	UNEP
10. Agreement on the Conservation of Bats in Europe (EUROBATS)[1]	1991	UNEP
11. Agreement on the Conservation of Cetaceans of the Black Sea, the Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS)1		ACCOBAMS Sec.
12. Agreement on the Conservation of Seals in the Wadden Sea1	1990	Ind. Sec.
13. Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS)1	1991	UNEP
14. Ramsar Convention on Wetlands (RCW)	1971	IUCN
15. World Heritage Convention	1972	UNESCO
16. International Coral Reef Initiative (ICRI)	1995	ICRI Sec.
17. Lusaka Agreement on Co-operative Enforcement Operations Directed at Illegal Trade in Wild Fauna and Flora	1994	KWS
3) Chemicals and Hazardous Wastes Conventions:		
18. Basel Convention on the Control of Transboundary Movements of hazardous Wastes Their Disposal	1989	UNEP
19. Basel Ban Amendment	1995	UNEP
20. Basel Protocol on Liability and Compensation	1999	UNEP
21. Rotterdam Convention on the Prior Informed Consent Principle for Certain Hazardous Chemicals and Pesticides in International Trade	1998	UNEP/ FAO
22. Future Stockholm Convention on Persistent Organic Pollutants	2001	UNEP[2]
4) Regional seas conventions and related agreements[3]		
23. Global Programme of Action for the Protection of the Marine Environment from Land-based Activities	1995	UNEP
24. Convention for the Protection of the Mediterranean Sea against Pollution (Barcelona)	1976	UNEP

Table 3 (Cont.).

MEA	Date adopted	Secretariat
25. Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution	1978	ROPME[4]
26. Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region (Abidjan)	1981	UNEP
27. Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific (Lima)	1981	CPPS[4]
28. Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment (Jeddah)	1982	PERSGA[4]
29. Convention for the Protection and Development of the Marine Environment of the Wider Cribbean Region (Cartagena)	1983	UNEP
30. Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region (Nairobi)	1985	UNEP
31. Convention for the Protection of the Natural Resources and Environment of the South Pacific Region (Noumea)	1986	SPREP[4]
32. Convention for the Protection of the Marine Environment of the Baltic Sea Areas(Helsinki)	1992	HELCOM[4]
33. Convention on the Protection of the Black Sea from Pollution (Bucharest)	1992	BSEP[5]
34. Convention for the Protection of the Marine Environment of the North-East Atlantic	1982	OSPAR[5]
35. Draft Convention for the Protection and Sustainable Development of the Marine and Coastal Environment of the Northeast Pacific5		UNEP[2]
36. Draft Convention for the Protection of the Marine Environment of the Caspian Sea5		
37. The East Asian Seas Action Plan	1981	UNEP
38. Protection of the Arctic Marine Environment	1991	PAME[6]
39. The Northwest Pacific Acton Plan (NOWPAP)	1994	UNEP
40. South Asian Seas Action Plan	1995	SACEP[4]
5) Land Conventions:		
41. United Nations Convention to Combat Desertification (UNCCD)	1992	UN

[1] The 17 regional seas conventions and action plans are a global mosaic of agreements with one overarching objective: the protection and sustainable use of marine and coastal resources. Protocols, amendments and agreements of regional seas conventions are not listed.

[2] Non-UN regional organizations.

[3] UNEP is providing the secretariat on an interim basis.

[4] Negotiations are expected to be completed in 2001.

[5] Regional body with its own secretariat established by the Arctic Council.

[6] These agreements, while independent treaties, were concluded under the auspices of CMS.

Conclusions and Outlook

The future development of science will strongly depend on basic research, but if we look into the actual reality of research funding, we see a rapid decline on a world-wide level. Governments everywhere are reducing research funds, with very few exceptions. What is behind this development? An analysis of the causes shows that sciences are not able to translate their research findings into comprehensible scenarios in order to convince the public, including politicians and decision makers about its importance for the cultural, social and economic development of human societies. Therefore, in contrast to some decades ago, we must show pro-actively what we can contribute, and especially what the contribution of soil scientific research might be. Moreover, we should not forget that problem oriented political discussions take place to an increasing extent on television, which means that we have to deliver our results and arguments with a vocabulary, which can be understood by the broad public (Dubois and Gershon, 1996; World Conference on Science, 2000).

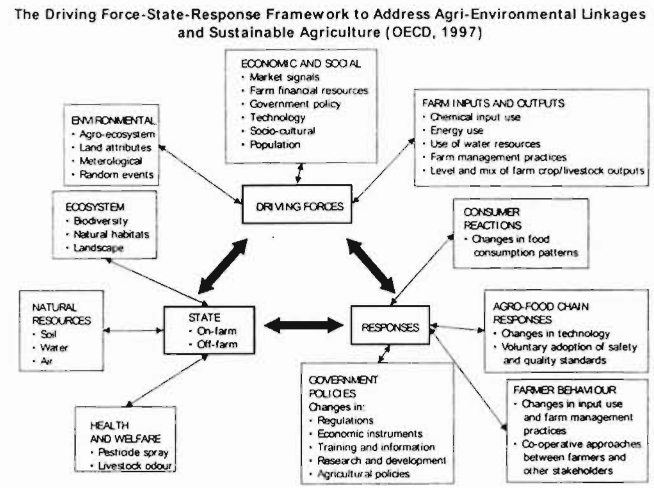

Figure 9 The Driving Force-State-Response Framework to address agri-environmental linkages and sustainable agriculture (OECD, 1997).

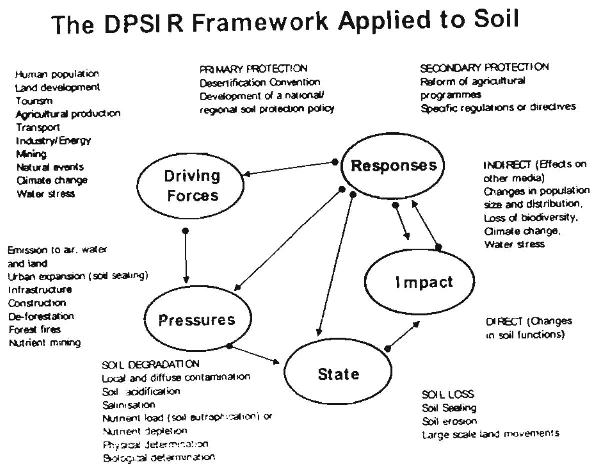

Figure 10 The DPSIR framework applied to soil (EEA, 1999).

Another challenge is the complexity of our system and the future development of research through specialization. There is a great danger that soil science is splitting into disciplinary approaches, like soil physics, chemistry, mineralogy, biology and others, forgetting that the soil system itself or as part of terrestrial ecosystems is the main target and not only its single parts, especially in relation to the many functions of soils for human societies and the environment. Therefore, new efforts in interdisciplinary and multi-disciplinary research in soil science are urgently needed, bridging between complexity and specialization.

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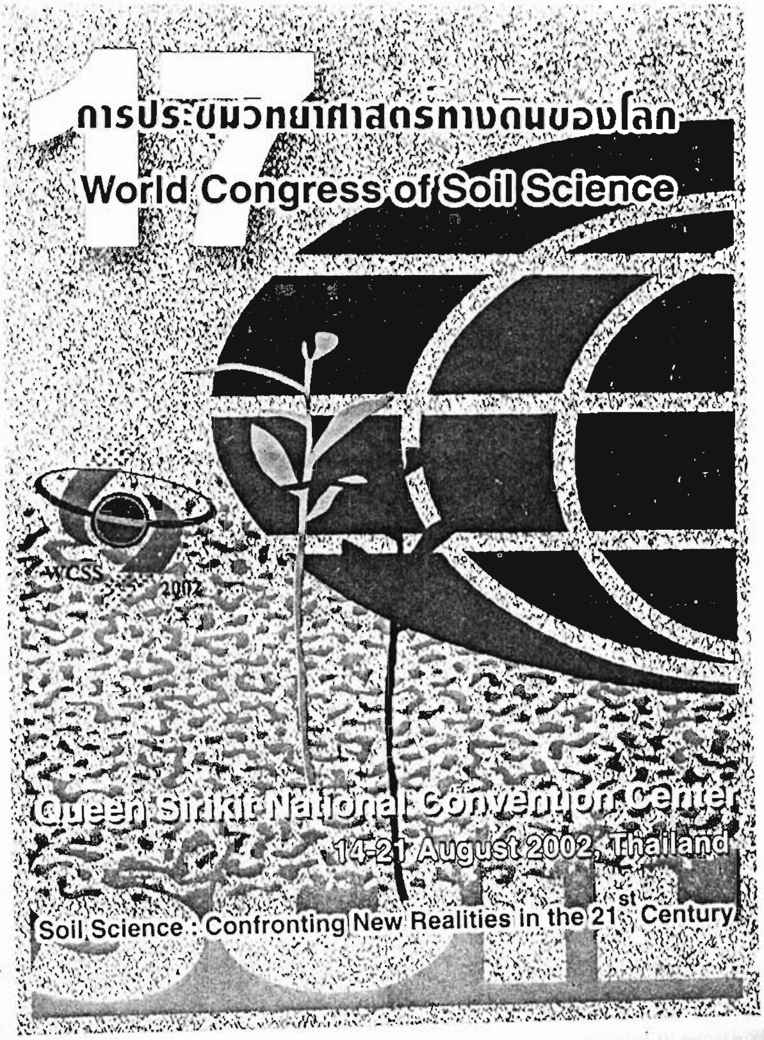
Tropical soil science: realities and challenges

ROJANASOONTHON S. and KHEORUENROMNE I.



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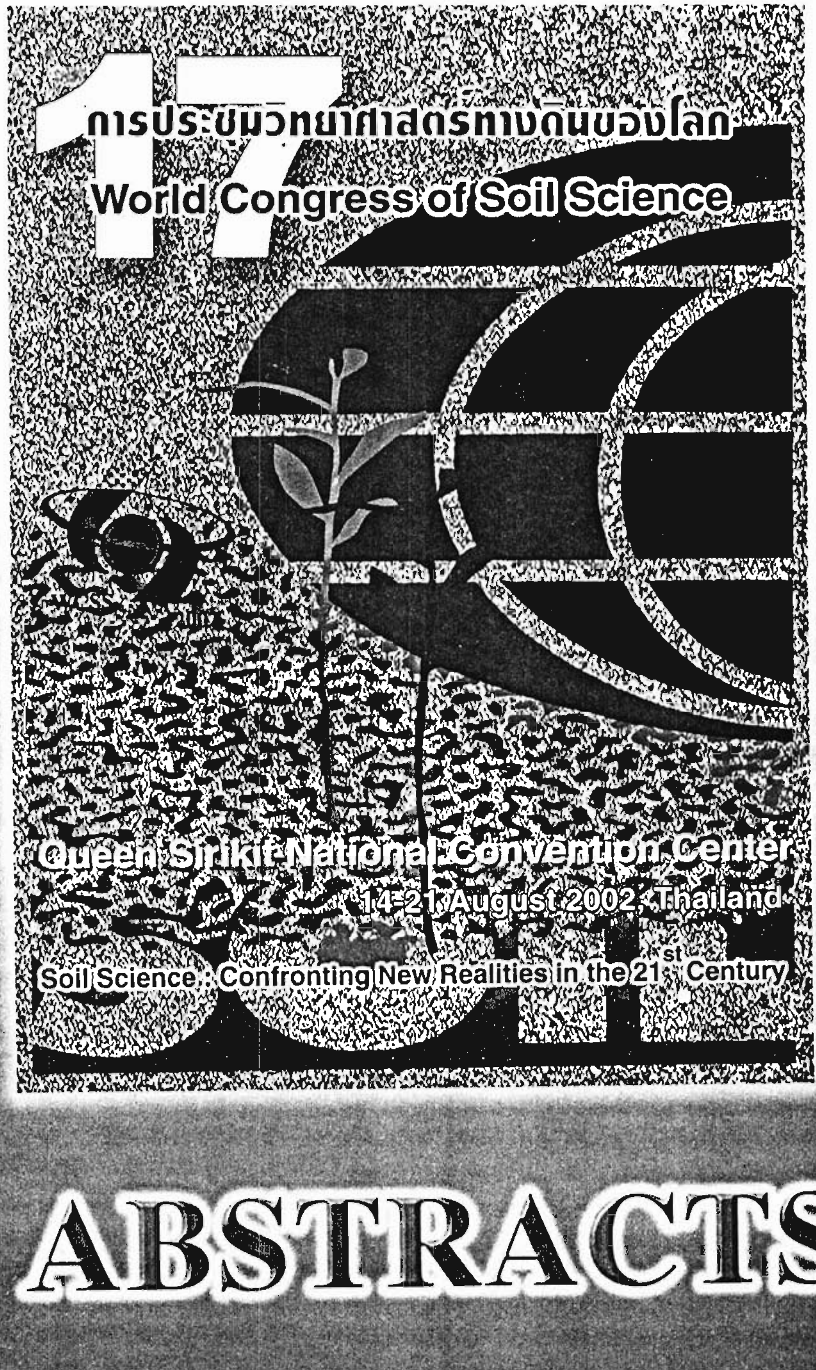

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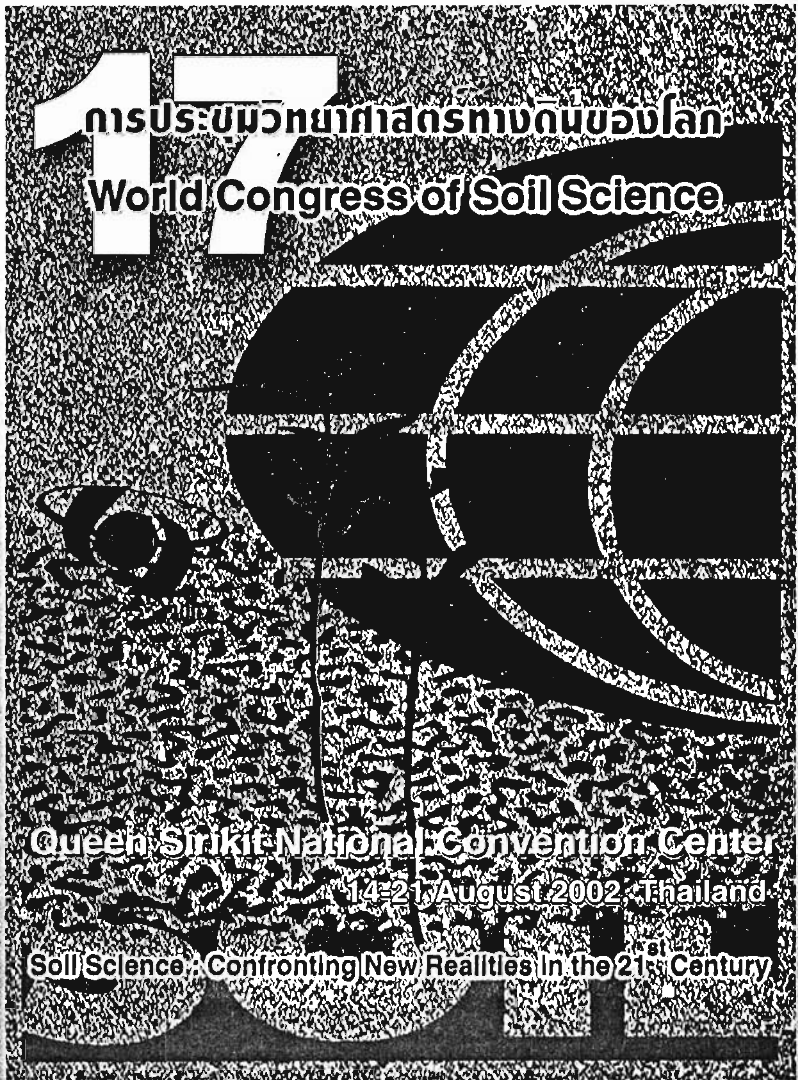

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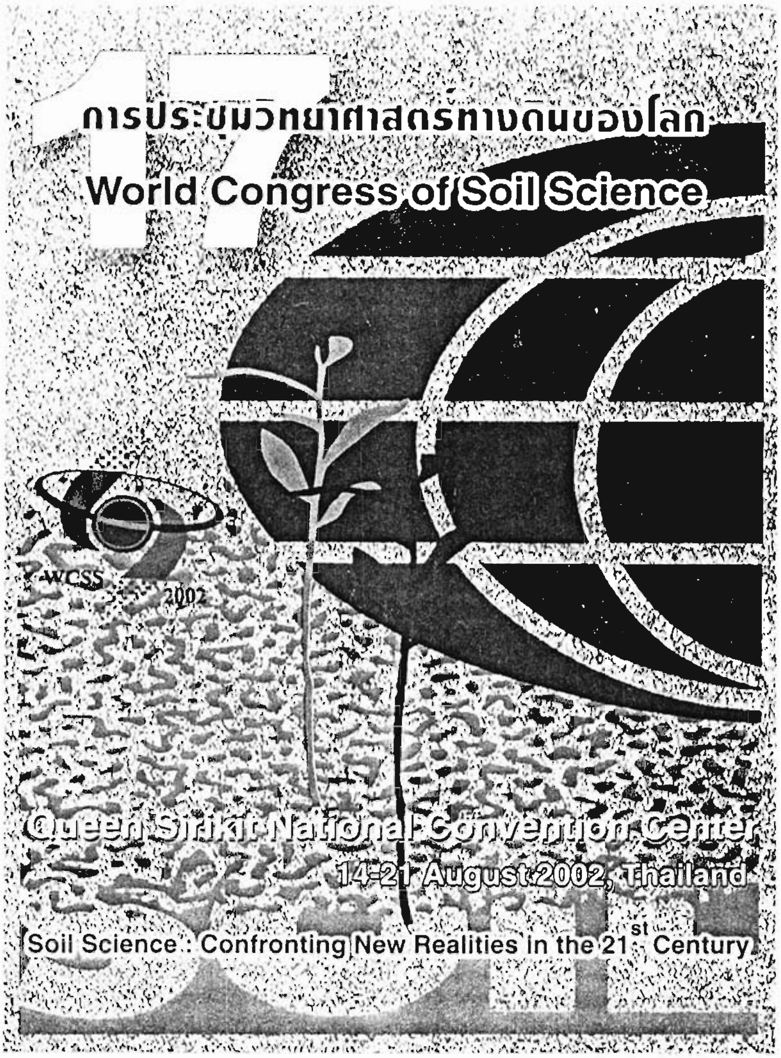

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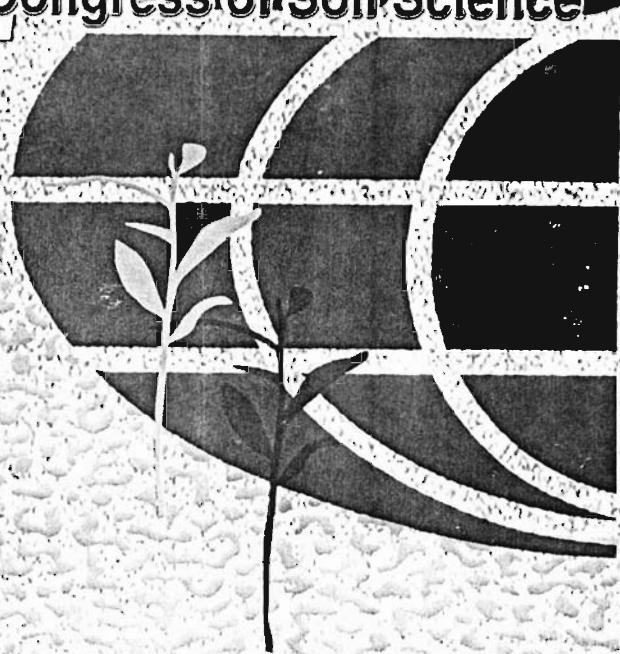


Queen Sirikit National Convention Center

14-21 August 2002, Thailand

Soil Science : Confronting New Realities in the 21st Century

CONGRESS GUIDE

Scientific and Technology Exhibition

N Processing in Grass Seed Crops Differing in Soil Drainage and Disturbance in Western Oregon, U.S.A.

GRIFFITH, Stephen M.[1], NELSON, Machelle A.[1], and OWEN, Jeffrey S.[2]

[1]USDA Agricultural Research Service, Corvallis, OR and [2]Institute of Earth Sciences, Academia Sinica, Nankang, Taipei, TAIWAN

ABSTRACT

Grass seed production comprises 55% of Willamette Valley's (Oregon, U.S.A.) land-use. Grass seed production is primarily a dryland crop that benefits from the high winter rainfall (>1100 mm) and cool temperatures of western Oregon. Due to the close association of many of the farm landscape's dissecting waterways, water quality can be directly impacted by crop management practices. There is increased interest by growers to improve water and soil quality through implementing more conservation practices into their farm operations. Conservation tillage, or direct seeding, returning post-harvest crop residues, and improving riparian habitat are examples of their proactive approaches to improving water quality and natural resource conservation. Traditionally, grass seed growers till their perennial grass seed fields every three to four years in preparation for a new grass seed crop, with the thought that tillage will enhance seed yield and quality. We have previously reported that high seed yield and quality can be maintained when using direct seeding, and at a reduced cost over tillage. **Research presented here expands our knowledge of the effects of tillage and direct seeding on various plant and soil parameters in a perennial grass seed cropping system.** Specifically, we determined the effects of direct seeding (no till) on soil and plant nutrition, as well as plant growth, seed yield, and plant N acquisition at two sites, each differing in soil drainage.

SITE DESCRIPTION

Well Drained Research Site

- Located in the Silverton Hills region of Marion County, of western Oregon.
- Soil is a Nekia-Jory Association, well drained, silty clay loam over clay.
- 'Bridgeport' fine fescue was planted spring of 1999.

Poor to Moderately Drained Research Site

- Located at Hyslop Research Farm in Benton County, western Oregon.
- The soil is a Woodburn soil series, poor to moderately drained, silty loam over fine sandy loam.
- 'Hounddog' tall fescue was planted, spring of 1999.

The Willamette Valley has a Marine climate with hot, dry summers and cool, wet winters. The mean (30-year average) annual precipitation is 1108 mm with 94% occurring between October to June. The annual mean temperature is 12°C.

Both sites were established in 1992 as part of the USDA-ARS research on Integrated Farming Systems. This USDA-ARS project contrasted alternative tillage, crop rotation, and residue management

METHODS

The *in-situ* buried bag method was used to quantify N mineralization (Eno, 1960) from September 1999 to June 2001, and an average incubation of 26 days was used to quantify N mineralization.

An intact soil core, 5 cm diameter by 15 cm deep was removed, sealed within a zip-seal polyethylene bag (approximately 27 by 28 cm; 1.75 MIL thickness) and replaced in its original position in the ground. The bag was covered with loose soil and litter to reduce exposure. Second and third cores were taken 10 to 15 cm away for determination of initial inorganic N (NO_3^--N and NH_4^+-N) concentrations.

One additional soil core (day 0) per incubation soil core was taken and placed in polyethylene bags and transported to the laboratory for analyses of baseline soil properties. Two separate sub-samples from the cores were extracted with 100 ml of 0.5 M K_2SO_4, shaken for 30 minutes on a rotary shaker at 350 rpm and filtered through a #1 Whatman filter. The filtrate was then analyzed for NO_3^-, NH_4^+, and total organic carbon (TOC). NO_3^- and NH_4^+ were analyzed using a Lachet Quick Chem 4200 analyzer. Additional sub-samples of soil were taken for determination of soil moisture by gravimetric methods.

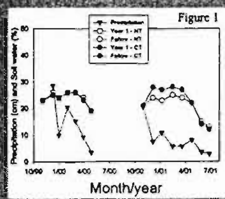
MBC was determined using the chloroform fumigation extraction method with 48-hour fumigation period. TOC was quantified with high temperature catalytic combustion and infracted detection on a Tekmar/Apollo 6000. Soil pH was measured using a glass electrode (1:2, soil: water ratio). Percentage of soil organic matter was estimated using a loss on ignition method.

SUMMARY

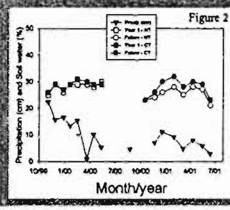
- In years of seasonally low precipitation, conventional tilled soils, with moderately- and well-drained characteristics, maintained higher soil water compared to no till soils (Figs. 1 & 2);
- Plant shoot biomass (Figs. 3 & 4) and seed yield (data not shown) was little affected by tillage treatment;
- Crop N uptake was directly related to the amount of biomass produced (Figs. 3-6);
- Net N nitrification was enhanced during the first seed production year following tillage and not in succeeding years (Figs. 9 & 10);
- Tillage reduced soil microbial biomass (MBC) in moderately- and well-drained soils (Figs. 7 & 8);
- Soils at the well-drained site maintained MBC levels over the season, in contrast to the moderately-drained soils where MCB declined from fall to summer. This was attributed to lower soil water content.

We conclude that although seed yield was not affected by soil tillage, soil abiotic and biotic factors were changed and may have had a direct impact on environmental quality. For example, enhanced mineralization brought about by tillage operations resulted in more nitrate produced at a time when plant N demand was lowest because of dormancy [initiated by soil drying (summer) or cooler temperatures (fall-winter)]. This nitrate surplus would have high leaching potential during the winter season.

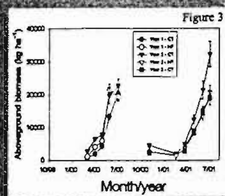
Moderately Drained Site

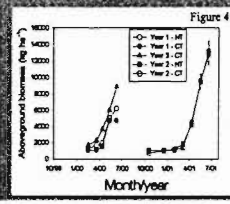


Well Drained Site

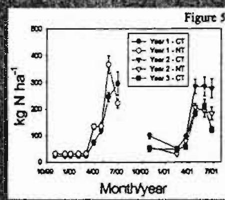


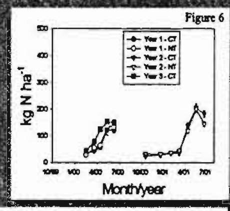
RESULTS: Overall, the 2000 – 2001 crop season was drier than the 1999 – 2000 season. Soil water diminished with declining rainfall. There was a greater tendency for the fallow tilled (CT) soil to maintain higher soil water during the low rainfall year compared to the no till (NT) soil.





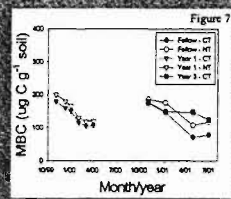
RESULTS: Tall fescue (Fig. 3) and fine fescue (Fig. 4) biomass production began about March and reached maturity by July. Except for Year 2 tall fescue during the 2000-2001 season, generally tillage had little influence on biomass production. Tall fescue produced twice the biomass of fine fescue.



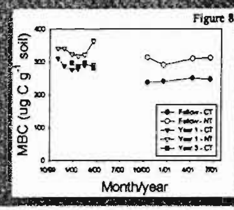


RESULTS: Tall fescue accumulated about 300 kg N ha^{-1} per year (Fig. 5) and fine fescue approximately 200 kg N ha^{-1}(Fig. 6). Each grass seed crop received a total of 134 kg N ha^{-1} in the spring.

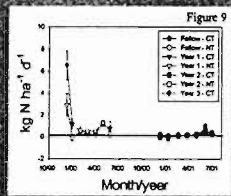
Moderately Drained Site

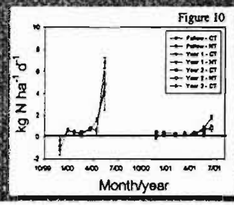


Well Drained Site



RESULTS: Microbial biomass (MBC) declined during the season at the moderately drained tall fescue site (Fig. 7). The well drained soils of the fine fescue crop had significantly greater MBC (Fig. 8) than the moderately drained site. At both sites following tillage, MBC was reduced compared to the untilled soil.





RESULTS: Interestingly, the moderately drained soil had higher rates of nitrification in the fall (Fig. 9), compared to the well drained soil (Fig. 10) where nitrification rates were greatest in spring. Nitrification was enhanced by tillage.

Soil Drainage	Season	Seed Year	Tillage Treatment	Annual Net Nitrification (N kg N ha^{-1} yr^{-1})
Well Drained	2000-2001	Fallow	No Till	75
			Till	153*
	1999-2000	Year 1	No Till	202
			Till	243*
	2000-2001	Year 2	No Till	51
			Till	79*
	1999-2000	Year 3	Till	199
Moderately-Drained	2000-2001	Fallow	No Till	46
				63
	1999-2000	Year 1	No Till	82
			Till	76
	2000-2001	Year 2	No Till	48*
			Till	35
	2000-2001	Year 3	Till	47

RESULTS: Total annual net nitrification was significantly (* = alpha 0.05 level) greater in tilled soil at the well-drained site but not for soils at the moderately drained site.

Acknowledgment

We acknowledge The Oregon Seed Council for their [illegible] support and [illegible] for their technical assistance.

Modelling Boron adsorption kinetics in Benchmark soils of Punjab, India

Sanjay Arora and D.S.Chahal
Department of Soils, Punjab Agricultural University
Ludhiana, India – 141 004. E-mail.: sarorapau@rediffmail.com

It is vital to understand the mechanism of boron adsorption on soil as plants respond primarily to B activity in soil solution. Knowledge on the kinetics of adsorption reaction may be essential for the sound prediction of nutrient availability to plants. A number of models have been used to describe the kinetics of adsorption process of boron. The work on this line in Indian soils is very limited. Hence, studies have been conducted to assess the kinetics of B adsorption and for providing information on the behaviour of B in benchmark soils of Punjab state, India.

Batch test was conducted to investigate the adsorption behaviour of B in twenty one surface (0-0.15 m) soils representing major soil series of Punjab. Background electrolyte (20 ml; 0.01 M $CaCl_2$) containing 40 μg B ml^{-1} as boric acid was added to 10 g of soil in 50 ml polypropylene centrifuge tubes in triplicate. The contents were allowed to equilibrate with intermittent shaking at $25 \pm 1^{\circ}$ C for different intervals ranging from 1 h to 72 h. at the end of the reaction time, suspension was centrifuged and filtered. The B concentration in the equilibrium solution was determined colorimetrically using Azomethine-H. The amount of B adsorbed at various time intervals were fitted to different kinetic models. The adsorption experiments were also conducted using the same soils. Calcium chloride solution (0.01 M ; 20 ml) containing varying concentration of B (1 to 100 μg ml^{-1}) as boric acid was added to soil (10 g). Shaken the contents were allowed to equilibrate to a predetermined equilibrium time (24 h) and centrifuged. Adsorbate concentration in the equilibrium solution was then determined as described above. Boron adsorption was modeled with Freundlich adsorption isotherm. Simple correlations were made to establish whether any relationship existed between soil properties and B adsorption parameters.

Boron adsorption pattern was characterized in all soils by an initial fast reaction followed by a slow reaction, probably due to slow diffusion of B in the soils. Boron adsorption was almost complete after 24 h of equilibrium, though complete equilibrium was not attained until 32 h had elapsed. The concentration of B in equilibrium solution reduced with fineness in texture. The Elovich equation was best of the various kinetic models studied to describe the rate of B adsorption as evidenced by the overall highest values of coefficient of determination (R^2) and lowest values of standard error (SE) of the estimate over the entire time range (Table 1). The power function was nearly as good as the Elovichian model in describing B adsorption kinetics in these soils.

Boron adsorption on soils conformed to Freundlich isotherm (Fig 1) over the concentration range. The Freundlich adsorption constant K and 1/n, which provides the estimate of adsorbent capacity and intensity, ranged from 1.086 to 5.445 μg g^{-1} and 0.561 to 0.868, respectively. The simple correlation (r) values varied from 0.957 to 0.998. The adsorption capacity constant (K) was correlated significantly with clay content (r= 0.569**) and CEC (r= 0.639**) of the soils.

The Use of 18S Ribosomal DNA to Assess the Diversity of Nematodes in European Grasslands

WAITE, I.S.[1], O'DONNELL[1], A.G., COLVAN[1], S.R., EKSCHMITT[2], K., BAKONYI[3], G., BONGERS[4], M., BONGERS[4], T., BOSTROM[5], S., DOGAN[2], H., HARRISON[1], A., KALLIMANIS[6], A., NAGY[3], P., SOHLENIUS[5], B., STAMOU[6], G.P., DAVIES[1], J.T., WOLTERS[2], V.

[1]Centre for Molecular Ecology, University of Newcastle, Newcastle Upon Tyne, United Kingdom; [2]Justus Liebig University of Zoology, Stephanstrassee 24, D-35390 Giessen, Germany; [3]Godollo University of Agricultural Sciences, Department of Zoology and Ecology, H-2103 Godollo, Pater K. u. I., Hungary; [4]Wageningen Agricultural University, Laboratory of Nematology, Post Box 8123, NL-6700 ES Wageningen, The Netherlands; [5]Swedish Museum of Natural History, Department of Invertebrate Zoology, Box 50007, S 104 05 Stockholm, Sweden; [6]Aristotle University of Thessaloniki, School of Biology, Department of Ecology, UPB 119, GR-54006 Thessaloniki, Greece

Abstract:

Molecular ecological techniques have been widely used to study bacteria in soil and to determine diversity in natural environments. The study of other soil organisms, such as nematodes, has proved more difficult by these techniques. This paper reports on the studies of nematode communities in European grassland soils by the exploitation of conserved regions in the 18S rDNA. Using 'specific' 18S rDNA oligonucleotide primers, nematode specific sequences were amplified from total community DNA in soil. These amplicons were subsequently used to study ecological diversity. A clone library was constructed and screened using restriction fragment length polymorphism (RFLP). Novel clones were sequenced and analysed phylogenetically. Amplicons were also used for denaturing gradient gel electrophoresis (DGGE). Bands from DGGE were excised, sequenced and analysed phylogenetically. Although the lack of available sequence data for nematodes made the design of specific primers difficult, the results show that molecular techniques can be used to analyse the genetic diversity of nematodes in soil.

Aims:

To develop a set of molecular tools that would enable genetic diversity of nematodes to be assessed from soil community DNA extract.

Materials and Methods:

Materials

Soil from six European grassland sites were used in this investigation. These soils lie on a climatic-cross gradient and represent six major natural and semi-natural European grassland types.

Sites were located in Germany (DE), Greece (GR), Hungary (HU), Netherlands (NL), Sweden (SE) and the United Kingdom (GB) (Ekschmitt 1999)

Methods

The 18S rDNA is a highly conserved region of DNA within Eukaryotes containing nine variable subunits, making it ideal for targeting specific conserved nematode sequences. Total community DNA was extracted using a CTAB method previously described (Griffiths 2000).

PCR was performed using specific primers (see table below) to anneal to conserved positions within the gene. The resultant PCR amplicons were then used in cloning and DGGE analysis.

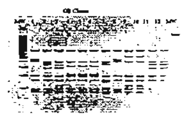
Primer Name	Target	Use	Reference
NEM F1*	Nematode 18S rDNA	Cloning / DGGE*	Waite et al., 2002
S3	Eucaryotic 18s rDNA	Cloning	Maiwald et al., 1994
NEM 896r	Nematode 18S rDNA	DGGE	Waite et al., 2002

* indicates the use of a GC Clamp (Muyzer 1993) for use on DGGE

PCR amplicons (NEM F1/S3) were cloned into the TOPO pCR2.1 vector and analysed using RFLP to identify novel clones for sequencing (figure 1).

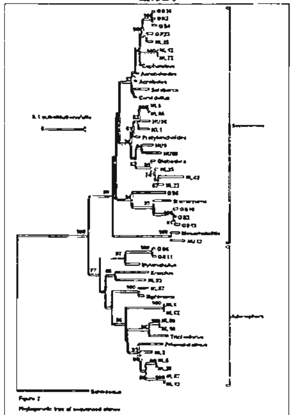
DGGE was used to separate PCR amplicons of the same molecular weight (NEM F1/NEM 896r) using a denaturing gradient on an acrylamide gel to generate a 'fingerprint' for each site (figure 3).

Cloning results:



RFLP analysis of PCR amplified nematode 18S rDNA from total soil community DNA.

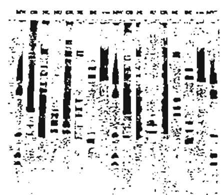
34 unique banding patterns were identified from the clone library and sequenced

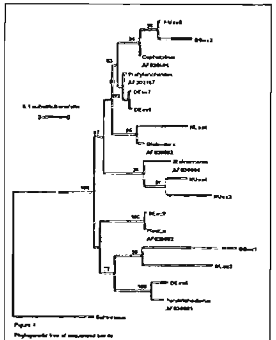


TREECON (Van de Peer and Gouy 1993) was used to construct the phylogenetic tree using the corrected distance of Galtier and Gouy (1995) and neighbor joining (Saitou and Nei 1987). The stability of the resultant tree topologies were assessed by 100 bootstrap re-samplings (Felsenstein 1985) and by comparison of the resultant trees with the most parsimonious tree.

- All sequences studied showed high similarities to nematode sequences held on-line
- 25 of the samples could be assigned to known nematode taxa
- 13 of the sequences were in a polyphyletic clade representing Adenophora
- 12 of the sequences were in the Secernentea clade

DGGE results:





11 bands were excised from the DGGE gel and the DNA was recovered by PCR. The PCR products were then sequenced.

- 4 sequences grouped in a clade that did not include known nematode sequences
- 7 showed high similarity with several known nematode taxa

- DEex8-*Paratrichodorus*
- SEex9-*Plectus*
- NLex4-*Globodera*
- HUex3-*Steinernema*
- HUex4-*Steinernema*
- HUex5-*Cephalobus*
- GBex2-*Cephalobus*

Discussion:

- The results clearly show that the 18S rDNA signatures can be used to study the genetic diversity of soil nematodes without the recourse to their isolation and morphological identification, however this work is on-going and the following need to be taken into account:
- The extraction procedure for total community DNA may fail to lyse particular nematode taxa, this would mean that it would not be possible to amplify them using PCR and they would not appear on the gel
- RFLP was used to select novel clones, but only one enzyme was found suitable to achieve the required resolution on an agarose gel, therefore clones showing the same banding pattern may in fact originate from different taxa
- It is possible that because of the size of the nematodes the sampling strategies normally used for measuring bacterial diversity using molecular methods need to be revised

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Centre for Molecular Ecology
Email address: tony.odonnell@newcastle.ac.uk

Fate of ^{15}N-Urea Blended with Composted Pig Manure for Chinese Cabbage

Woo-Jung Choi, Sang-Mo Lee[1], Hee-Myong Ro, Seok-In Yun and Jeong-Han Kim

Soil Environment Laboratory, School of Agricultural Biotechnology, College of Agriculture and Life Sciences, Seoul National University, Suwon 441-744, Korea; [1]National Instrumentation Center for Environmental Management, College of Agriculture and Life Sciences, Seoul National University, Suwon 441-744, Korea

Abstract

To utilize composts more efficiently, combining composts with fertilizer to meet crop requirements is an appealing alternative. A pot experiment was conducted to study the effect of application rate of composted pig manure blended with chemical fertilizer on the availability, immobilization, and loss of fertilizer-N. Chinese cabbage [*Brassica campestris* (L.) Samjin] plants were cultivated for 30 and 60 days. ^{15}N-Labeled urea (5.24 ^{15}N atom%) was added to soil at 450 kg N ha^{-1}, and unlabeled compost (0.37 ^{15}N atom%) was added at 0, 200, 400, and 600 kg N ha^{-1}. The amount of plant-N derived from urea was not affected by compost application at rate of 200 kg N ha^{-1}. However, compost application at 400 and 600 kg N ha^{-1} significantly ($P<0.05$) increased plant assimilation of N from urea irrespective of sampling time, probably because of physicochemical changes in the soil properties allowing urea-N to be assimilated more efficiently. Immobilization of urea-N linearly increased with increasing rate of compost application at the both growth periods, resulting from increased microbial activities using organic C in compost. With increasing rate of compost, total recovery of urea-N (as percentage of added N) by Chinese cabbage and soil increased from 71.5 to 95.6% and from 67.0 to 88.2% after 30- and 60-days of growth, respectively. These results suggest that increasing rate of compost application increases plant uptake of fertilizer-N blended with compost and enhances immobilization of fertilizer-N, which leads to decreased loss of fertilizer-N.

Introduction

◆ To utilize composts more efficiently, combining low amendment rates of composts with sufficient fertilizer to meet crop requirements is an appealing alternative.

◆ Combined application of fertilizer with compost can lead to an increase in the availability of nutrients and crop yield.

◆ The effects of compost on the availability and fate of fertilizer-N when applied together are not yet well-understood.

◆ Crop availability and the fate of fertilizer-N blended with compost may differ depending on the application rate of compost.

Objectives

◆ To estimate the effect of application rates of compost on crop uptake, immobilization, and loss of fertilizer-N blended with compost.

Materials & Methods

^{15}N-labeled urea : 5.24 ^{15}N atom %

Compost & Soil

Parameter	Compost	Soil[a]
pH (1:5)	8.1	5.3
Org-C (g kg^{-1})	376	20.2
Total N (g kg^{-1})	20.6	1.3
NH_4^+ (mg N kg^{-1})	1135	10.3
NO_3^- (mg N kg^{-1})	380	17.8
C/N ratio	18.2	15.5

[a] Sandy loam (USDA classification)

N application rates

Treatment	Urea (mg N pot^{-1})	Compost (mg N pot^{-1})
UC0	4500	0 (0)[a]
UC1	4500	2000 (9710)
UC2	4500	4000 (19420)
UC3	4500	6000 (29130)

[a] As dry matter (g) pot^{-1}

Pot experiment

◆ Pot (30 × 30 cm^2) ◆ 10 kg of soil ◆ Three replicates

◆ Chinese cabbage (one seedling for each pot)

◆ Aboveground parts of plant were collected at 30 and 60 days after transplanting.

◆ At each sampling time, soil sample was also collected.

Analyses

◆ Total-N content of plant and soil samples were determined using a continuous-flow stable isotope ratio mass spectrometer (IsoPrime-EA, Micromass, UK) linked with a CN analyzer.

◆ N content and ^{15}N atom % of 2 M KCl non-extractable N were determined using IsoPrime-EA after removing of inorganic N from soil sample through KCl extraction.

Calculation & Statistical Analyses

◆ Total amount of N derived from ^{15}N-labeled urea (NDFU) was calculated for crop and soil samples by the isotope method as follows:

$$NDFU = T \times (A_s/A_f)$$

where, T is total amount of N in the urea-amended sample, A_s is atom % excess ^{15}N in the urea-amended sample, and A_f is atom % excess ^{15}N in applied urea.

◆ Total amount of N derived from compost (NDFC) in crop was calculated using regression method.

◆ Total amount of plant-N derived from soil (NDFS) was determined by subtracting (NDFU+NDFC) from total plant-N.

◆ The NDFU of 2 M KCl extractable soil-N was calculated as the difference between NDFU of total soil-N and NDFU of 2 M KCl non-extractable N.

◆ The recoveries of N by crop and soil were expressed as percentages of N applied to each pot.

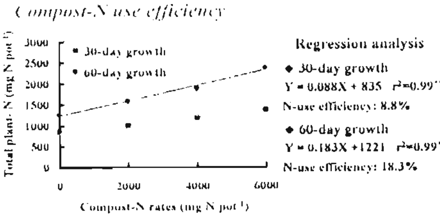
◆ Data were statistically analyzed in a one-way ANOVA using Generalized Linear Models procedure to compare significant differences (at the 95% confidence level) among the treatments.

Results & Discussions

Dry matter yields & N uptake of Chinese cabbage

Treatment	DMY (g pot^{-1})		Total plant-N (mg pot^{-1})	
	30-day	60-day	30-day	60-day
UC0	17.7	60.9	850	1249
UC1	20.0	97.0	996	1581
UC2	22.0	103.1	1170	1883
UC3	24.1	109.2	1378	2369
LSD	1.9	5.5	53	70

Compost-N use efficiency



NDFU, NDFC & NDFS (mg N pot^{-1})

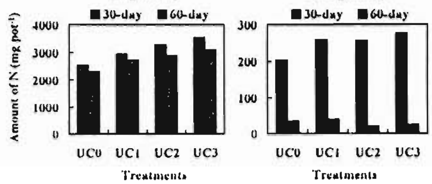
◆ Increase in NDFU with increasing rates of compost

TRT	30-day			60-day		
	NDFU	NDFC	NDFS	NDFU	NDFC	NDFS
UC0	467 (10.4)[a]	0	383	680 (15.1)	0	1249
UC1	461 (10.2)	176	359	716 (15.9)	366	1581
UC2	484 (10.8)	352	334	779 (17.3)	732	1883
UC3	484 (10.8)	528	366	847 (18.8)	1098	2369
LSD	10 (0.2)	45	56	55 (1.2)	78	70

[a] Urea use efficiency as expressed % of added urea-N

Immobilization of urea-derived N

◆ Increase in immobilization of urea-derived N with increasing rates of compost

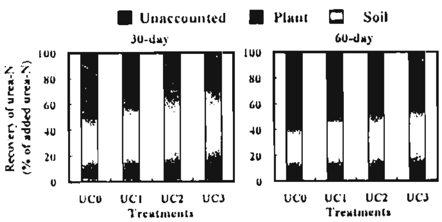


LSD between treatments are 165 for 30-day and 63 mg N pot^{-1} for 60-day

LSD between treatments are 58 for 30-day and 12 mg N pot^{-1} for 60-day

Recoveries of ^{15}N-urea

◆ Unaccounted portion (N loss) decreased with increasing rates of compost



LSD between treatments are 2.6 for soil, 0.2 for plant, and 2.5% for unaccounted portion.

LSD between treatments are 1.0 for soil, 1.2 for plant, and 2.1% for unaccounted portion.

Conclusions

◆ Application of compost above a critical level (e.g. 9710 kg ha^{-1}) increased plant uptake of urea-N because of positive effects of compost applied in combination with urea.

◆ Immobilization of urea-N increased in proportion to application rates of compost, mainly because of stimulated microbial activities.

◆ Microbial immobilization led to higher retention of urea-N, thus resulting in less loss of urea-N.

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Dietary effects on the turnover and plant utilisation of animal manure nitrogen in soil

Peter SØRENSEN, José A. FERNÁNDEZ, Martin R. WEISBJERG & Peter LUND
Danish Institute of Agricultural Sciences, Research Centre Foulum, Denmark
E-mail: peter.sorensen@agrsci.dk

Introduction

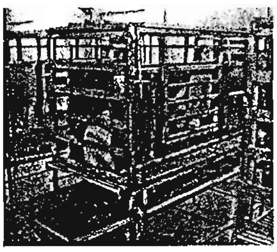
Animal manure is an important nitrogen (N) fertiliser in agriculture and it has significant influence on the long-term accumulation of organic nitrogen in soil and on N losses to the environment.The manure composition is influenced by the diet composition.

Objectives

We studied effects of the composition of diets fed to pigs and dairy cows on:

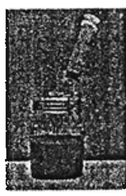
- the composition of the slurry (= the liquid mixture of faeces and urine)
- the turnover of N during slurry storage and its decomposition in soil
- the potential plant availability of slurry N
- residual manure N left in soil after the first crop

Methods



Twelve complete diets with variable protein content, fibre content and fibre type were formulated and fed to growing pigs and sows.

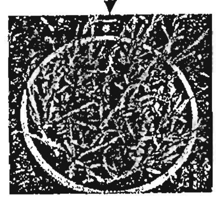
Seven different forage types supplemented with concentrates were fed to dairy cows at a high milk production level, and without concentrates to cows at a low production level.



Urine and faeces were mixed and stored as slurry for 20 weeks

Slurries were applied to a loamy sand, incubated for 12 weeks at 8°C and the net release of mineral N determined.

Feed samples were analysed for: total N, crude fibre, NDF, lignin, and in vitro digestibility of the feed. Manure samples were analysed for: total N and C, mineral N, and soluble C.



Slurries (130 kg total N/ha in pig slurry, 180 kg N/ha in cattle slurry) were applied to small confined plots in the field by simulated direct injection before sowing spring barley to determine the first-year N utilisation (negligible N loss). Nitrogen uptake in barley grain and straw was measured and the mineral fertiliser equivalent of slurry N was calculated.

Results

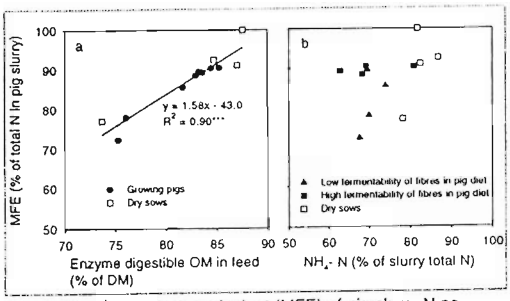


Fig. 1. Mineral fertiliser equivalent (MFE) of pig slurry N as affected by feed digestibility and slurry ammonium-N after storage.

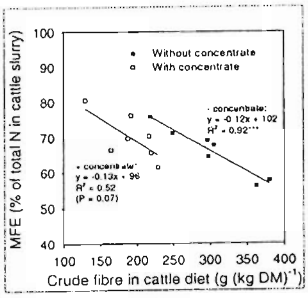


Fig. 2. Mineral fertiliser equivalent (MFE) of cattle slurry N as affected by the concentration of crude fibre in the feed.

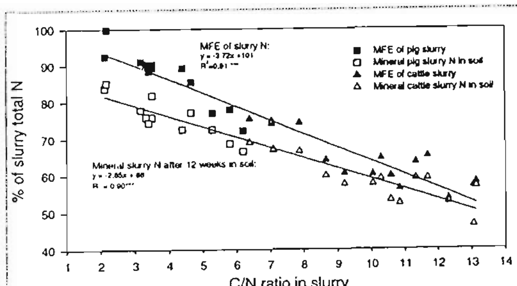


Fig. 3. Mineral fertiliser equivalent (MFE) and net release of mineral N from cattle and pig slurry after 12 weeks' soil incubation as affected by the C/N ratio in the stored slurry.

Conclusions

- The fibre content of the diet has significant influence on the turnover and potential utilisation of pig and cattle slurry N in soil
- The plant availability of pig slurry N can be predicted from enzyme digestible organic matter in the feed
- The plant availability of slurry N from dairy cattle at a low feeding level can be predicted from the concentration of crude fibre in the diet
- The plant availability of slurry N could not be predicted from the proportion of ammonium N after storage, indicating that the mineralisation of organic N was variable, but the net N release and N utilisation were well predicted from the C/N ratio of stored slurry
- Residual manure N left in soil after the first crop varied from <10% to 30% from pig slurries and 20% to 45% from cattle slurries

Ministry of Food, Agriculture and Fisheries
Danish Institute of Agricultural Sciences

Long Term Effects of Soil Tillage Systems on Sugarcane Yield and Soil Properties[1]

Ian Grange[1], Preecha Prammanee[2] and Praphan Prasertsak[2]

[1] Faculty of Environmental and Resource Studies, Mahidol University, Nakhon Pathom 73170, Thailand. Email: fridg@mahidol.ac.th.
[2] Suphanburi Field Crops Research Center, U-Thong, Suphanburi 72160, Thailand.

Abstract

Many sugarcane soils in Thailand are undergoing structural degradation after being planted to sugarcane for long periods of time. Conventional, minimum and no-tillage systems were assessed by measuring changes in soil physical properties and cane yields over time, together with cost analyses evaluation. Initial traffic wheelings were shown to cause most of the inter-row soil compaction resulting in greater bulk density values than in plant rows. There was a relationship between the no-tillage treatment, with the highest upper soil bulk density (1.52 g cm^{-3}) having lower average yields (79.5 t ha^{-1}) and the less compacted soil of the conventional system (1.35 g cm^{-3}) having higher yields (87.0 t ha^{-1}). The minimum-tillage systems with the lowest amount of soil compaction (1.34 g cm^{-3}) also corresponded with the best yield returns (96.0 t ha^{-1}) and the best net profit of all treatments. The differences in yield, between tillage treatments were only significant in the plant and first ratoon crop, and not the second and third ratoon. The differences in soil bulk density, thought to have been caused from both traffic wheelings and natural soil compaction processes, were only found in the upper 35 cm depth, below which all values for each system were similar (range of 1.43-1.51 g cm^{-3}). Penetration resistance measurements indicated a weak plough pan at 30-40 cm, in all treatments, probably formed prior to experimentation and not yet alleviated in any treatment. Maintenance of a high water table reduces the strength of this allowing root growth. Despite the low level of mechanisation in the reduced tillage treatments compared with the conventional tillage, herbicide and labour costs offset a substantial part of the savings. The best net profit was for the minimum tillage without subsoiling.

Key words: strategic tillage, plant growth zone, traffic wheelings

[1] 17th World Congress of Soil Science, 14-21 August 2002, Bangkok Thailand

Oxalic Acid Perturbation of Imogolite Formation and the Impact on Cadmium Adsorption

Masayuki TANI*, Chen LIU**, and Pan Ming HUANG**

*Department of Agro-Environmental Science, Obihiro University of Agriculture and Veterinary Medicine, Inada, Obihiro, Hokkaido 080-8555, JAPAN.
**Department of Soil Science, University of Saskatchewan, 51 Campus Drive, Saskatoon, SK, S7N 5A8, CANADA.

ıbstract

Oxalic acid, which is mostly present in the soil solutions of Andisols and Spodosols, perturbed the formation imogolite. However, the effectiveness in impeding the interaction of hydroxy-Al ions with ›rthosilicic acid and subsequent formation of imogolite is lower than citric, as indicated by the results of x-ray diffractograms and IR absorption spectra. The morphological features of synthetic mogolite and x-ray noncrystalline aluminosilicates formed under the influence of oxalate can be observed by using the contact-mode AFM. With increase in the oxalate/Al molar ratio, the threads-like itructures which are characteristic of imogolite decreased and the spheroidal and ill-defined amorphous particles increased in the AFM three-dimensional images. The present AFM study also shows that ›xalic acid can induce the change in the size of threads-like structures of imogolite and spheroidal particles of noncrystalline aluminosilicates, decreasing in the length and width of threads-like itructures and increasing in the diameter of spheroidal particles with increase in the oxalate/Al molar ratio.

The adsorption of Cd by these particles was a very rapid reaction and actually completed within 10 min. After 240 min, 3.15 to 9.35 % of the Cd were adsorbed by the precipitates. The amount of :d adsorbed decreased with the increase in the oxalate/Al molar ratio. The decrease in the adsorption rate of Cd by the perturbed imogolites, observed in the present study, is attributed to the ›artial blocking of the reactive Al-OH sites on the outer surface of imogolite tube by COOH groups through complexation reaction. The present results suggest that the influence of oxalic acid on the :hape and size of imogolite and noncrystalline aluminosilicates, and their subsequent surface properties and Cd adsorption on these minerals merits further attention.

›bjectives

We examined the morphological features of synthesized imogolite under ambient conditions by using the AFM. We also investigated the role of oxalic acid in affecting the formation of imogolite and he morphological features of synthesized imogolite and noncrystalline aluminosilicates affected by oxalic acid during their formation by using the contact-mode AFM and related methods. Furthermore, we xamined the Cd adsorption by the imogolite and noncrystalline aluminosilicates formed under the influence of different concentrations of oxalic acid.

Iaterials and methods

›aration of the Parent Solution

1.6 mmol L^{-1}, Al 3.2 mmol L^{-1}, Si/Al molar ratio = 0.5, OH/Al molar ratio = 2.0,
xalate/Al molar ratio = 0.00, 0.02, 0.04, 0.06, 0.08, 0.10
uted with deionized distilled water (The pHs of the solutions were 4.35 ± 0.01)

thesis of Precipitation Products

e parent solution was heated at 98 °C for 110 h.
parated by filtration through a membrane filter of 0.1 μm pore size
lyzed (MW cut off = 3500) against deionized distilled water until Cl^- free
›eze dried and gently ground to pass through a 0.5 mm sieve

mination of Precipitation Products

termination of Si, Al, and organic C in the precipitates
ay diffraction: Rigaku D/Max-RBX x-ray diffractometer with FeKα radiation
·ared (IR) spectra: Perkin-Elmer 983 Infrared spectrometer with KBr discs

nic Force Microscopy of Precipitation Products

e precipitates were dispersed by ultrasonication at 150 W for 5s in an ice bath.
o drops of the suspension (20 mg L^{-1}) were deposited on a watch glass.
e sample was dried for 1month at room temperature (23.5 ± 0.5 °C).
e AFM three-dimensional images of the imogolite were taken by using a ›noScope III atomic force microscope (Digital Instruments, Inc., CA) in air ıd at room temperature.
anner: Type 1881E, Scanner size: 15 μm, Mode: Contact mode, Scanning te: 18.31 - 27.47 Hz

tic Studies of Cd Adsorption

50 mg sample of the precipitates was equilibrated with 100 mL of 1 mmol L^{-1} NO_3 and 0.01 mmol L^{-1} $Cd(NO_3)_2$ solution at pH 5.0.
e suspensions were agitated at 25 °C for 4 h.
aliquot of 10 mL of the suspension was withdraw at 10, 20, 40, 60, 120, and 10 min, and then filtered through a 0.1 μm membrane filter.
e concentration of Cd remaining in the filtrate was determined by flame AAS.

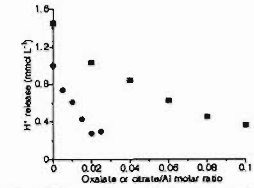


Fig. 1. Proton release in the systems at the oxalate/Al molar ratio from 0 to 0.10 and the citrate/Al molar ratio from 0 to 0.025. The data of citrate was quoted from Lou and Huang (1989). ■, oxalate; ●, citrate.

Table 1. Composition of the synthetic imogolite and precipitates formed both in the absence and presence of oxalic acid.

Oxalate/Al molar ratio	SiO_2	Al_2O_3	Oxalate	Si/Al molar ratio
	(g kg^{-1})†			
0.00	221	546	0	0.69
0.02	175	579	33.9	0.51
0.04	155	627	81.0	0.42

† On the basis of oven-dried weight

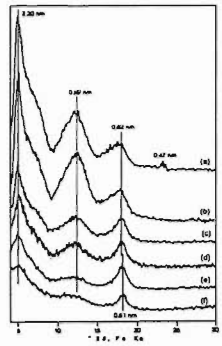


Fig. 2. X-ray diffractograms of the synthetic imogolite and precipitates formed both in the absence and presence of oxalic acids. Initial oxalate/Al molar ratio: (a) 0, (b) 0.02, (c) 0.04, (d) 0.06, (e) 0.08, and (f) 0.10.

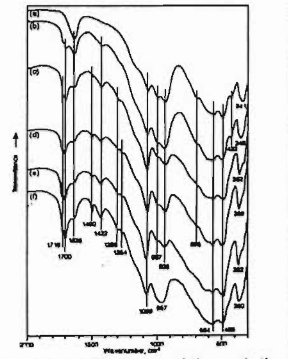


Fig. 3. Infrared (IR) spectra of the synthetic imogolite and precipitates formed both in the absence and presence of oxalic acid. Initial oxalate/Al molar ratio: (a) 0, (b) 0.02, (c) 0.04, (d) 0.06, (e) 0.08, and (f) 0.10.

ıesults and discussion

Oxalic acid perturbed the formation of imogolite remarkably at the higher concentrations (oxalate/Al ar ratios of 0.08 and 0.10). However, the effectiveness in impeding the interaction of hydroxy-Al : with orthosilicic acid was lower compared with citric acid and other strong complexing organic acids, indicated by the results of amounts of H^+ released into solutions during the reaction (Fig. 1), x-ray ·ractograms (Fig. 2), and IR absorption spectra (Fig. 3). The present study suggests that oxalic acid ıificantly inhibits the interaction of hydroxy-Al ions with orthosilicic acid and the subsequent recipitation as indicated by the decrease in SiO_2 contents and Si/Al molar ratios with the increase in oxalate/Al molar ratio (Table 1), leading to the formation of structurally disordered and non-stalline materials incorporated with oxalic acid as shown in the x-ray diffractograms (Fig. 2) and the absorption spectra (Fig. 3).

The morphological features of synthetic imogolite and x-ray noncrystalline aluminosilicates formed as ected by oxalate were observed distinctively by using the contact-mode AFM (Fig. 4). Optimum ·asonification and sufficient air drying of imogolite on the sample holder at room temperature before A scanning are critical to avoid the breakdown of imogolite particles and the etching of a sample face. At the oxalate/Al molar ratios of 0 and 0.02, the imogolite appeared in the AFM three-ensional deflection images as threads and curved. With the increase in the oxalate/Al molar ratio, threads-like structures, which are characteristic of imogolite, decreased and the spheroidal and ill-defined amorphous particles increased in the AFM images. the oxalate/Al molar ratio of 0.10, any threads-like structure was not observed. The present AFM study also shows that oxalic acid induced the change in the : of threads-like structures of imogolite and spheroidal particles of noncrystalline aluminosilicates. The length and width of threads-like structures decreased ble 2) and the diameter of spheroidal particles increased with the increase in the oxalate/Al molar ratio from 0 to 0.10.

:inetic studies of Cd adsorption on imogolite and noncrystalline aluminosilicates were conducted at pH 5.0, using 10^{-5} mol L^{-1} $Cd(NO_3)_2$ solution. The adsorption Cd by these particles was a very rapid reaction and actually completed within 10 min (Fig. 5). After 240 min, 9.4 % of the added Cd was removed from the ıtion of the imogolite suspension system. Less Cd was adsorbed by the perturbed imogolites than by imogolite. The percent adsorption of Cd decreased with the ·ease in the oxalate/Al molar ration from 0.02 to 0.10. At the highest oxalate/Al molar ratio of 0.10, no more than 3.2 % of the added Cd was adsorbed on aluminosilicate. From a pedological viewpoint, the incorporation of oxalate in the noncrystalline aluminosilicates would hamper the retention of Cd in the surface illuvial horizons of Andisols and Spodosols.

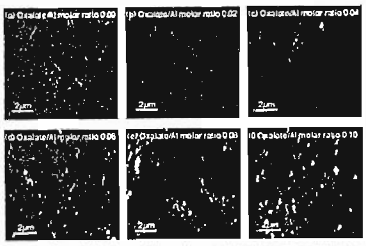


Fig. 4. The AFM three-dimensional deflection images of the synthetic imogolite and precipitates formed in the absence and presence of oxalic acid. Initial oxalate/Al molar ratio: (a) 0, (b) 0.02, (c) 0.04, (d) 0.06, (e) 0.08, and (f) 0.10.

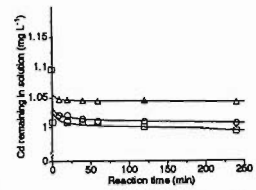


Fig. 5. Time function of Cd adsorption on the imogolite and noncrystalline aluminosilicates as affected by oxalic acid at the oxalate/Al molar ratios of 0.02 and 0.04. The oxalate/Al molar ratios of; □, 0.00; ○, 0.02; △, 0.04.

Table 2. Diameter and length of threads-like structures of the synthetic imogolite and precipitates as affected by oxalic acid.

Oxalate/Al molar ratio	Diameter (nm) Avg. ± S.D.		Length (μm) Avg. ± S.D.	
0.00	78.3 ± 15.6	d‡	1.56 ± 0.40	d
0.02	65.7 ± 12.9	c	1.26 ± 0.35	c
0.04	53.4 ± 13.2	b	0.83 ± 0.24	b
0.06	44.2 ± 11.1	a	0.57 ± 0.14	a
0.08	N.A. †		N.A.	
0.10	N.A.		N.A.	

† N.A., Not applicable.
‡ Values within columns followed by the same letter are not significantly different at the 0.05 level by using Fisher-LSD test.

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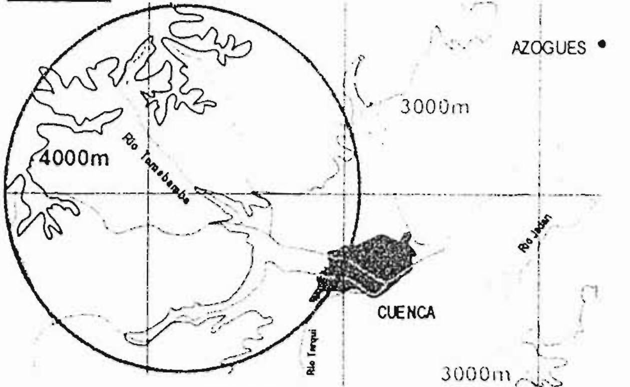
Humus nature of the soils in the upper Western Andes (Southern Ecuador)

BECH Jaume[1], SOKOLOVSKA Maria[2], PETROVA Lidia[3], TONON L.[4], LANSAC A.[5]

[1] Soil Science Chair. Faculty of Biology.University of Barcelona. Avda.Diagonal, 645. 08028 Barcelona (Spain). Email:jabechbo@porthos.bio.ub.es
[2] Forest Research Institute.BAS. 132 Bulv.Kl.Ohridski.1756 Sofia (Bulgaria). Email:mariagrozeva@hotmail.com
[3] N.Poushkarov Institute for Soil Science and Agroecology.1000 Sofia (Bulgaria).
[4] University of Cuenca (Ecuador).
[5] Applied Physics Departament. Polytechnical University of Catalonia (Spain)



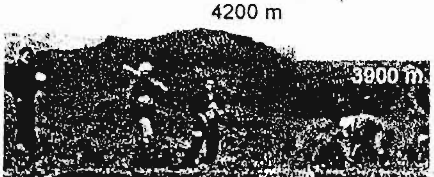
OBJECTIVES

This study is a preliminary work to establish the main characteristics of humus-amount, composition and changes with altitude of soils in the Western Andes, Azuay region. Southern Ecuador.

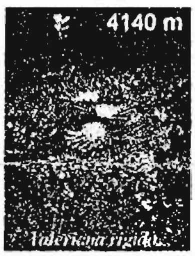
MATERIALS AND METHODS

The research area is located approximately between latitude 2° 40'to 2°50'S and longitude 79°10'to 79°20'W. A hypsometric soil sequence made up of twelve sites was chosen between altitudes of 2950 and 4200 in the Tomebamba river valley, Western Andes, which includes the Cajas national park, situated near to Cuenca city in direction WNW to Guayaquil. The following analysis were made:- Total organic carbon using the Tyurin method; Humus composition by the Kononova- Belchikova method, etc.

4200 m



The happy end of hard sampling



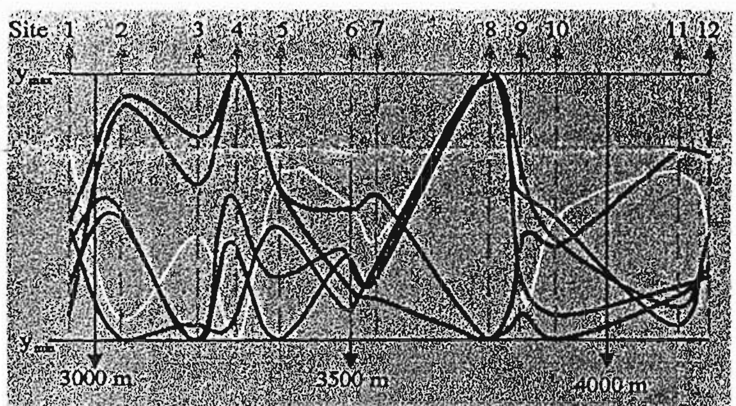
Valeriana rigida

sampling a peaty soil

flat cushion of Plantago rigida

Polylepis reticulata (high montane forest)

peaty soil over fluvioglacial materials



	Organic C (%)	Orlov index	C_{ha}/C_{fa}	E_4/E_6	C / N	pH_w
y_{max}	34,0	26,91	2,12	9,89	35	5,7
y_{min}	10,9	2,65	0,37	3,35	16	4,1

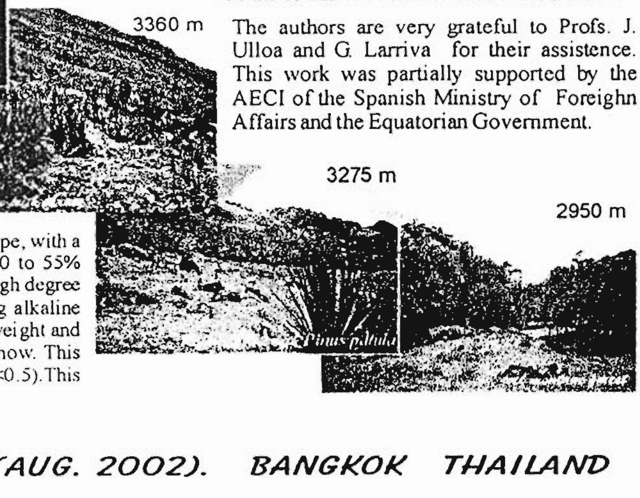
3770 m

IMPORTANT FINDINGS

A) The humus of the studied soils in Cajas park have some common features : 1) High acidity (mainly 4 to 5). 2) High C/N ratio (16 to 37) in the surface horizons. 3) Very high amounts of humus , mainly in the surface (18.9 to 59.24). 4) Humic acids are free or bound by iron and aluminium oxides. 5) The humus of all the studied soils (except site 8) is over 30% extractable with alkaline solutions.

This means that the humus are mature and their Cha/Cfa relationship is between 0.36 to 2.12. 7) The vertical zonality of the hypsometric sequence of Cajas park is irregular. This is due to the presence of patches of aloctonous volcanic ashes and other sites (mainly in the steep morrenic area at 3700m at site 8) that contain aquic moisture regim

Stipa ichu with coated mosses



Pinus patula

.B) There are three humus systems : 1)**Acidic mull**. From fulvic to fulvic- humic acid type, with a low degree of humification. 2) **Andic mull**. With a very high amount of humus 30 to 55% extractable with alkaline solutions and C/N from 16 to 25. 3) **Mor humus**. With a very high degree of raw humus, over 55%, a very small part of which (10 to 16%) is extractable using alkaline solutions. The C in the extract was at best about 6% and very similar in it's molecular weight and structure to fulvic acids. This data was unexpected and has not been published until now. This humus has a very low degree of humification, with fulvic type of humus (Cha/Cfa ratio <0.5).This humus system was found in the Fibric Histosols of site 8.

ACKNOWLEDGEMENTS

The authors are very grateful to Profs. J. Ulloa and G. Larriva for their assistence. This work was partially supported by the AECI of the Spanish Ministry of Foreighn Affairs and the Equatorian Government.

RELATIVE EFFECTIVENESS OF VARIOUS Cu FERTILIZERS IN IMPROVING GRAIN YIELD OF WHEAT AFTER THREE ANNUAL APPLICATIONS ON A Cu-DEFICIENT SOIL

Agriculture and Agri-Food Canada

S. S. Malhi[1], L. Cowell[2], D. Leach[1] and R. Kutcher[1]

[1]Agriculture and Agri-Food Canada, P.O. Box 1240, Melfort, Saskatchewan, Canada S0E 1A0

Phone: 306-752-2776, Ext. 230; Fax: 306-752-4911; E-Mail: malhis@em.agr.ca

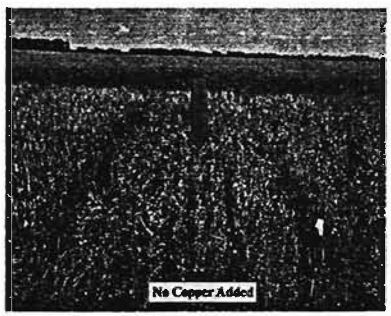
[2]WESTCO, Saskatchewan Wheat Pool, Tisdale, Saskatchewan

BACKGROUND

- Copper (Cu) deficiency is often associated with coarse-textured soils.
- Wheat is probably the most sensitive cereal to Cu deficiency, though some cultivars of wheat are less affected by the Cu deficiency than others.
- The deficiency of Cu is not wide spread in Saskatchewan, but it can cause a serious reduction in grain yield and quality of wheat when it occurs.
- Yield responses of cereals to Cu fertilization have been investigated in western Canada, but information is lacking on the effects of different Cu sources, formulations, methods and times of application in correcting Cu deficiency on wheat.

OBJECTIVE

- To determine the relative effectiveness of various sources, formulations, methods, times and rates of Cu on grain yield of wheat.



MATERIALS AND METHODS

- Location: Porcupine Plain
- Soil: Dark Gray
- Mean Precipitation: 450 mm
- Growing Season: May to August
- Crop (Cultivar): Hard Red Spring Wheat (AC Barrie)
- Cu Sources:
  - Cu Fert 1 Cu Chelate Granular
  - Cu Fert 2 Cu Sulphate Granular
  - Cu Fert 3 Cu Oxysulphate I Granular
  - Cu Fert 4 Cu Oxysulphate II Granular
  - Cu Fert 5 Cu Chelate-EDTA Liquid
  - Cu Fert 6 Cu Sequestered I Liquid
  - Cu Fert 7 Cu Sulphate/Chelate Powder (Soluble)
  - Cu Fert 8 Cu Sequestered II Liquid
- Times and Methods Cu Application:
  - Incorporated (Prior to Seeding)
  - Seed-placed (at Seeding)
  - Foliar (4-Leaf and Flag-Leaf)
- Rates of Cu: Various (Table 1)
- Other Fertilizers: Blanket Application of N, P, K and S Fertilizers
- Data Recorded: Grain Yield, Protein Content and Total Cu in Grain

SUMMARY AND CONCLUSION

1999:

- Grain yield of wheat increased substantially with foliar application of Cu at the flag-leaf growth stage with Cu Fertilizers 5, 6 and 7 in the initial year of application.

2000:

- Zero-Cu check produced grain yield of 1620 kg/ha.
- Grain yield increased to 2676, 2812, 2697 and 2574 kg/ha with foliar application of Cu Fertilizer 5, 6, 7 and 8 at the flag-leaf growth stage, respectively.
- With foliar application at the 4-leaf growth stage, Cu Fertilizer 5 increased yield moderately to 2440 kg/ha and Cu Fertilizers 6 and 7 tended to increase yield.
- Cu fertilizers, when incorporated into soil or placed in seedrow were not effective in correcting Cu deficiency on wheat (except Cu Fertilizer 1 incorporated into soil at 2.0 kg Cu/ha tended to increase grain yield, but not significantly).
- In treatments where Cu application increased seed yield, quality of seed was also improved compared to the Cu-deficient wheat.

2001:

- Grain yield in the zero-Cu check was 1262 kg/ha .
- With foliar application, the grain yield increased markedly with Cu Fertilizers 5, 6, 7 and 8 at flag-leaf growth stage and with Cu fertilizers 5, 6 and 7 at the 4-leaf growth stage.
- With incorporation treatments, the grain yield increased with Cu Fertilizers 1, 2, 3 and 4 at 2.0 kg Cu/ha, and with Cu Fertilizers 1 and 2 at 0.5 kg Cu/ha.
- Some seedrow Cu placements (Cu Fertilizers 1 and 2 at 1.0 kg Cu/ha) also increased grain yield.

Summary:

- The results suggest that for immediate correction of Cu deficiency in wheat, foliar application of some Cu fertilizers at flag-leaf growth stage can be used, but soil applications of granular Cu fertilizers may take more than three years (depending on soil-climatic conditions and management practices) to prevent any Cu deficiency on Cu-defficient soils.

Grain yield of wheat with different sources, rates, times and methods of Cu application at Porcupine Plain 1999 (0.5 mg Cu/kg in 0-15 cm soil) (1st year results).

	Grain yield (kg/ha)			
Treatment	CuFert 1	CuFert 2	CuFert 3	Cu Fert 4
Incorporated (0.5 kg Cu/ha)	1567	1680	1523	1467
Incorporated (2.0 kg Cu/ha)	1821	1591	1655	1453
Seedrow (0.25 kg Cu/ha)	865	1347	1271	1886
Seedrow (1.0 kg Cu/ha)	1588	1831	1441	1348
	CuFert 5	CuFert 6	Cu Fert 7	CuFert 8
Foliar-4 Leaf (0.25 kg Cu/ha)	1844	1849	1572	1522
Foliar - Flag Leaf (0.25 kg Cu/ha)	2709	2571	2555	1343
Control (no Cu) 1566				

Grain yield of wheat with different sources, rates, times and methods of Cu application at Porcupine Plain in 2000 (0.5 mg Cu/kg in 0-15 cm soil) (second year results).

	Grain yield (kg/ha)			
Treatment	CuFert 1	CuFert 2	CuFert 3	Cu Fert 4
Incorporated (0.5 kg Cu/ha)	1770	1914	1211	1264
Incorporated (2.0 kg Cu/ha)	2236	1958	1651	1758
Seedrow (0.25 kg Cu/ha)	804	1250	1602	1800
Seedrow (1.0 kg Cu/ha)	1801	1898	1252	1424
	CuFert 5	CuFert 6	Cu Fert 7	CuFert 8
Foliar-4 Leaf (0.25 kg Cu/ha)	2440	2062	2131	1742
Foliar - Flag Leaf (0.25 kg Cu/ha)	2676	2812	2697	2574
Control (no Cu) 1620				

Grain yield of wheat with different sources, rates, times and methods of Cu application at Porcupine Plain in 2001 (third year results).

	Grain yield (kg/ha)			
Treatment	CuFert1	CuFert2	CuFert3	CuFert4
Incorporated (0.5)	2076	2188	1248	1345
Incorporated (2.0)	2724	2823	2049	2299
Seedrow (0.25)	815	1336	1404	1838
Seedrow (1.0)	2162	2324	1380	1641
	CuFert5	CuFert6	CuFert7	CuFert8
Foliar-4 Leaf	3016	2861	3003	1866
Foliar - Flag Leaf	2641	2492	2165	2417
Control (no Cu) 1262				

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Canada

Effect of boron fertilizer on red clover seed production in Chilean volcanic soils

DEMANET R. and MORA M.

Universidad de La Frontera, Temuco, Casilla 54-D. Chile

The Ninth Region, 37-39 °S, 74 -71 °W, has a climate similar to that of temperate seed growing areas of the world. Rainfall averages 1.400-2.000 mm per annum. The two soil groups used for growing seed are classified as Ultisol and Andisol. Ultisols have phosphate retention of aproximately 60% and organic matter of approximately 9%, whereas Andisols have high phosphate retention (approximately 90%) and high organic matter (16-18%). *Trifolium pratense* L. seed production area reaches to 5,000 ha in Southern Chile and the average yield is less than 300 kg ha^{-1}. The principal factor which regulates the crop production is a high acidity condition in these soils, hampering nutrient availability. Boron is highly deficient in these soils. The database of soil service laboratory in the Universidad de La Frontera indicates that the 50% of soils have less than 0.5 mg kg^{-1}. The availability of boron to the plants generally decreases with an increase in soil pH, resulting in lime-induced boron deficiency in some cases. Boron plays an important role in the pollination process and deficiency affects pollen germination and pollen tube growth in the plant. Boron is also involved in many other essential processes, including the translocation of sugar and other biochemicals, protein synthesis, nodule formation in legumes and regulation of carbohydrate metabolism (McLaren and Cameron, 1994)

The aim of this work was to determine the boron fertilizer requirements on *Trifolium pratense* L. seed production growing in volcanic ashes derived soils.

The research was developed in an Andisol of Freire Serie with 0.32 mg kg^{-1} of Boron and pH 5.5. A split plot design with four replicates was used to evaluate the effect of 5 doses of boron fertilizer. The doses were 0, 1,2,3,4 and 6 kg B ha^{-1}. Previously seedling the soil was liming with 1 ton of calcite. The experiment was conducted over two years (1999/2000 and 2000/2001). The boron source was calcite boronatre applied in the first year in the row and overcastted in the second year.

The result indicate a very good relationship between boron dosis and yield. In the first year the maximum average yield was 1,096 kg ha^{-1} when it was apply 6 kg of B ha^{-1}. With the same dosis in the second year the average yield was 1,401 kg ha^{-1}. The yield increase from 24% to 73% with the boron rate from 1 kg ha^{-1} to 6 kg ha^{-1} reaching in the soil over 1 mg kg^{-1}. The increase boron in the soil depends the interaction liming and boron rate.

Keywords: *Trifolium pratense*, boron, pollination, seed production, Andisol

Effect of long term integrated use of farmyard manure and inorganic fertilizers on soil P availability

DHILLON N.S., JOSAN M.D. and BRAR B.S.

Department of Soils, Punjab Agricultural University, Ludhiana, India -141 004

Continuous use of differential amount of inorganic P fertilizers and farmyard manure (FYM) over the years in a particular cropping system may create variable soil P fertility and affects sorption and desorption behavior of added P. In the present study, soil samples were drawn at 0-15 cm, 15-30 cm, 30-60 cm and 60-90 cm soil depth from a long term fertilizer experiment on maize-wheat cowpea (fodder) cropping system at Punjab Agricultural University, Ludhiana (India) initiated in 1971 where fertilizer treatments consisted of an absolute control, 50%, 100% and 150% NPK, 100% N and 100% NPK + FYM (100% NPK means 320 kg N + 83 kg P + 110 kg K ha^{-1} to one crop cycle, source of P is SSP & FYM at the rate of 10 t ha^{-1} before the seeding of maize). There was a considerable build up of available P with all rates of P application both in surface and sub-surface soil after 28 years of cropping. However, in control plot (no P added), available P declined from 8.8 kg ha^{-1} to 6.0 kg ha^{-1} and this magnitude of decline was of higher order in plots receiving N alone. The result also indicated that P availability declined sharply with soil depth. The values of available P were of higher order in 150% NPK treated plot through out the profile, showing the possibilities of P movement in the super optimal P amended plots.

As the amount of P added increased, the amount of P adsorbed also increased correspondingly and was of higher order in plots receiving 100% N or absolute control. Further, increasing rates of long term P fertilizations caused reduction of P adsorbed and it increased with soil depth. Adsorption maxima were the maximum in control and 100% N treatments and were the least in 100% NPK + FYM treatment. The affinity constant for P showed wide variation among different long term fertilizer treatments. The values of Freundlich constants were the highest in absolute control and 100% N treatments. Differential buffering capacity (DBC) and Maximum buffering capacity (MBC) had the lowest values in 100% NPK + FYM treatment followed by 150% NPK treatment. Adsorption maxima, MBC, DBC and extent of P adsorption showed a significant relationship with various yield/P uptake values of wheat crop. Phosphate desorption was far less when compared to P adsorption. Desorption maxima (Dm) was the maximum in 100% N treatment followed by control and it was correlated significantly with both relative yield and dry matter production.

Keywords: long-term, integrated fertilizer use, P availability, P adsorption

Effect of soil organic amendments on the growth and grain yield of rice under lowland conditions in Ghana

BURI Mohammed M. (1), ISSAKA Roland N. (1) and WAKATSUKI Toshiyuki (2)

(1) Soil Research Institute (CSIR), Academy Post Office, Kwadaso, Kumasi, Ghana
(2) Faculty of Life and Environmental Science, Shimane University, Matsue, Japan

Ghana is not only faced with such problems as environmental degradation, declining soil fertility, low soil productivity and erratic rainfall patterns but also with low mineral fertilizer usage (poor resource farmers). However, rice consumption continues to increase annually thereby leading to large annual imports of the crop. This has led to the crop being currently ranked as a number one priority (cereal) in terms of production.

For sustainable agriculture, production has to be fine-tuned with efficient economic and environmentally sound production principles that lead to proper soil fertility management. To this end, for any integrated sustainable nutrient management system, plant nutrient supply packages need to be developed for the poor resource farmer (main rice growers in Ghana). With this in mind, three soil organic amendments (poultry manure, cattle manure, rice husk) were used either solely or in combination with mineral fertilizer on rice at three different sites (Potrikrom, Biemso No. 1, Biemso No. 2) in the forest agro-ecological zone of Ghana. Sole organic amendments were applied at a rate of 7.0 t ha^{-1}, sole mineral fertilizer was applied at N, P_2O_5, K_2O (90-60-60) ha^{-1} while for combinations, half rates (organic amendments + mineral fertilizer) were applied.

Results from this study show that organic amendments significantly contributed to total growth and grain yield of rice. A combination of poultry manure and mineral fertilizer (half rates) gave similar yield as mineral fertilizer (full rate) at two out of the three locations. Rice grain yields were 6.2, 7.3 and 4.1 t ha^{-1} each for the combination (poultry manure + mineral fertilizer) at Potrikrom, Biemso No. 1 and Biemso No. 2 respectively while full rate mineral fertilizer gave 6.6, 7.3 and 3.9 t ha^{-1} respectively. A combination of organic amendments with mineral fertilizer out-yielded organic amendments alone at all of the three sites. Among the organic amendments, Poultry manure showed a greater promise by out-yielding both cattle manure and rice husk at all three sites.

At Site 1 (Potrikrom), sole Poultry manure out-yielded the control by 256%, Cattle manure by 171% and rice husk by 97%. At Site 2 (Biemso No. 1), poultry manure out-yielded the control by 77%, cattle manure by 74% and rice husk by 53% while at Site 3 (Biemso No. 2), the trend was similar with poultry manure out-yielding the control by 154%, cattle manure by 103% and rice husk by 90%.

Considering the long term beneficial effects of organic matter on both soil physical and chemical characteristics, environmental soundness and the availability and affordability of these materials within the Ghanaian society as against the high cost of mineral fertilizers (100% imported), organic amendments could be relied upon as not only effective sources of plant nutrients that can significantly help in increasing rice production under effective management but also as effective sources of preventing any further soil/environmental degradation and maintaining/improving soil productivity.

Keywords: forest ecology, Ghana, lowlands, organic amendments, rice

Micronutrients residual effects in vineyards on the calcareous soils

MALAKOUTI M.J., BYBORDI A. and MAJIDI A.

Tarbiat Modarres University and Researchers, Soil and Water Research Institute, Iran

Grapes, being one of the high calorie foods, could become a good source for exchange currency, if improved and exported as high quality raisins. An experiment was designed to test the additional effects of potassium and micronutrients on the grape yield, size and color, and its nutrient contents for the first harvest and the following two years. No fertilizers were supplied to the vineyards in the third year. Two vineyards more than 15 years old were selected at Malayer and one vineyard at Malakan. During mid April 1998 the Malayer and Malakan vineyards were treated with fertilizers. Each vineyard was divided into two halves. One half received grower's conventional fertilizers. The other half received balanced fertilization. The treatments were completed before the growing season, after the vineyard soils had been sampled for analyses. Two years later the plant leaves as well as the soils were sampled for test results. The vineyards yielded 87% more grapes in the first year, when the average yield from the treated sections of the two Malayer vineyards had increased from 21.8 t ha^{-1} (control section) to 32.4; at Malakan the treated sections yielded 72 t ha^{-1} compared with 28 for the control sections. Furthermore, the sugar content had increased by 4% for Malayer and by 7% for Malakan. The resulting raisins were also larger with a more desirable yellowish color. The concentrations of iron, zinc, and copper in the grapes from the control section of Malayers vineyards were 23, 11 and 7 mg kg^{-1} while these values were 27, 9, and 8 and 1.7 respectively for the fertilizer treated grapes. These measurements were made during the August of the second year of treatments for Malayer vineyards and after the first treatment for Malakan vineyards. In the latter case the grapes iron, zinc and copper contents were 20, 7, and 4 mg kg^{-1} respectively for the control sections and 38, 12, and 7 mg kg^{-1} for the treated sections. The results for the three consecutive years show that the soil application of fertilizers will improve grape yield and quality for at least two years and on the basis of soil and climatic conditions, the yields maybe higher for the third year.

Keywords: micronutrients availability, grape, yield, quality, calcareous

Nutrient balance and use efficiency by soybean in a Nigerian Alfisol

ADURAMIGBA-MODUPE V.O. (1), TIJANI-ENIOLA H. (2) and JAGTAP S.S. (1)

(1) International Institute of Tropical Agriculture, PMB 5320, Ibadan, Nigeria
(2) Agronomy Department, University of Ibadan, Nigeria

Field studies were conducted during the 1995 and 1996 growing seasons at Ibadan (7° 56′ N; 3° 45′ E) – a derived savanna in Nigeria, to evaluate the dynamics and balance sheet of soil N and P and measure N and P use efficiency (kg grain per kg available soil N and P) under two N (0 and 60 kg ha^{-1}) and fractional recovery (FR) model calculated P (MP): (0, 15, 30, and 60 kg ha^{-1}) rates, with soybean as a test crop. Mineral N ranged from 46.1 to 57.5 kg ha^{-1}, while P varied between 1.9 and 5.4 kg ha^{-1}. The mean N content across all P levels showed 6% decrease by 60 kg N ha^{-1} (60N) rate over the control (0 kg N ha^{-1}), while that of P was 20% less than the control. Addition of 60 kg N kg ha^{-1} with MP gave the highest grain and stover yields of 1.77 and 3.62 Mg ha^{-1} respectively; the grain yield was 18% better than that of the soil P (0 kg P ha^{-1}) rate. Grain N and P uptake was enhanced by applications of N and P fertilizers, with the MP and 60N combinations having the highest amounts of 92.1 kg N ha^{-1} and 1.9 kg P ha^{-1} respectively. The mean N and P uptake was 19 and 6% higher than the control, respectively. The amounts of P in the soil have a strong relationship with P uptake, leading to higher grain yield. Mean N and P balances (-121 kg N and –7.7 kg P ha^{-1}) showed ($P<0.05$) depletion at higher N and P fertilizer levels suggesting those output components (crop uptake, N and P losses from soil) accounted for the negative balances. The MP rate however increased N and P balances by 19 and 14% over the control. NUE and PUE of soybean decreased ($P<0.05$) with increasing rates, suggesting that under low N or P, differences in fertilizer NUE and PUE were due to variation in N and P utilization, whereas at high levels, differences were due mainly to variation in uptake efficiency. The integration of nutrient use efficient legume and balance studies with the MP rate can lead to a better understanding of the fertility of Nigerian Alfisols.

Keywords: nutrient balance, efficiency, soybean, Alfisol, fractional recovery, model

Potassium leaching under different nitrogen managements

ALFARO Marta (1), JARVIS Steve (1) and GREGORY Peter (2)

(1) Institute of Grassland and Environmental Research (IGER), North Wyke Research Station, Okehampton, Devon, EX20 2SB, UK
(2) University of Reading, Department of Soil Science, Reading Berks, Reading, RG6 6DW, UK

Nitrogen (N) affects the availability of potassium (K) in soils. Applications of N increase levels of dry matter production and decrease the levels of available soil K. It was expected that smaller losses of K would occur from systems given high N inputs.

The study was carried out in small farmlets receiving 0 or 280 kg N ha^{-1} a^{-1} as mineral fertiliser (N-, N+) with or without Farm Yard Manure (FYM), and with and without artificial drainage. Two drainage seasons were studied and amounts of total K lost and K concentrations in the leachates were measured. The trend of K concentration in leachates over time and its interactions with rainfall intensity and flow characteristics were analysed.

Preliminary results showed that total K losses were 52% higher in the N+ plots and 50% lower in the D+ plots. The first results reflect the higher K concentration measured in the samples obtained from N+ treatments, related to the application of FYM. The second effect was probably related to the higher levels of dry matter production observed in the D+ treatments during the growing season prior the drainage period in study.

The incorporation of N to the system should reduce the amounts of K lost when no K inputs are made to the system at critical points of the drainage season, such as previous to heavy rainfall events. Rainfall controlled K losses by leaching by affecting the total amount of drainage generated.

Keywords: potassium, leaching, grassland systems, nitrogen

Catch crops in organic farming systems without livestock husbandry: model simulations

MÜLLER Torsten (1), JENSEN Lars Stoumann (2), MAGID Jakob (2), NIELSEN Niels Erik (2), HANSEN Søren (3) and THORUP-KRISTENSEN Kristian (4)

(1) Dept. of Soil Biology and Plant Nutrition, Faculty 11, University of Kassel, Nordbahnhofstr. 1a, D-37213 Witzenhausen, Germany
(2) The Royal Veterinary and Agricultural University, Dept. of Agricultural Sciences, Plant Nutrition and Soil Fertility Lab., Frederiksberg, Denmark
(3) The Royal Veterinary and Agricultural University, Dept. of Agricultural Sciences, Agrohydrology and Bioclimatology Lab., Høje Tåstrup, Denmark
(4) Danish Institute of Plant and Soil Science, Dept. of Horticulture, Research Centre Aarslev, Denmark

This paper presents simulations of the soil-plant-atmosphere model DAISY based on an organic crop rotation with incorporation of different catch crops following pea as a leguminous cash crop. Special emphasise was put on the simulation of N-mineralisation/-immobilisation and of soil microbial biomass N. The DAISY model was able to simulate soil mineral N and soil microbial biomass N after soil incorporation of catch crop plant residues to some extend. Several processes need further attention and may be integrated into the DAISY model: (1) soil tillage induced mobilisation of organic material including considerable amounts of organic N, (2) winter killing of sensitive plant species and varieties, (3) decomposition of plant residues at the soil surface as occurring after winter killing, (4) decomposition of easily decomposable plant residues at low temperatures, (5) soil microbial residues as an organic pool temporarily protected against turnover. Furthermore, reliable criteria for the subdivision of green plant residues into an easily decomposable pool and a more recalcitrant pool have to be developed.

Keywords: organic farming, catch crop, DAISY, modelling, mineral N, soil microbial biomass

Nitrogen and phosphorus responses to wheat under FYM application

GUPTA A.P., NARWAL R.P. and ANTIL R.S.

Department of Soil Science, CCS Haryana Agricultural University, Hisar 125 004, India

The results from the long-term field experiments conducted at various locations indicated that the productivity of the soil is decreasing due to the decrease in the organic matter content of the soils. The results of another long-term (starting winter 1968) field experiment under a pearl millet-wheat cropping system indicate that application of nitrogen responded linearly up to the highest dose i.e. 120 kg N ha^{-1} at all the levels of farmyard manure ranging from 0 to 90 t FYM ha^{-1} y^{-1}. It was also concluded that application of 15 t FYM ha^{-1} y^{-1} preferably to wheat could sustain higher productivity. Several workers reported that the fertilizer N dose could be reduced under manured conditions. Therefore another field experiment was initiated in 1996-97, to study the response of nitrogen and phosphorus under manured conditions. Farmyard manure was applied in winter at 15 t FYM ha^{-1} y^{-1}. Nitrogen was applied at 0, 40, 80, 120, 160, 200, and 240 kg N ha^{-1} and phosphorus at 0, 30, and 60 kg P_2O_5 ha^{-1} to wheat crop. The experiment was conducted in randomized block design keeping three replicates of each treatment. In summer pearl millet was grown on residual nutrients. At maturity, the crop was harvested and the grain and straw yields were recorded.

The results indicate that wheat crop responded to nitrogen application but did not respond to phosphorus application after two years of FYM application. Therefore the data for last two years was selected to study the N responses to wheat. The response of wheat to N application was quadratic for both the years - 1998-99 and 1999-2000. The dose of N for highest grain yield was 188 kg during 1998-99 and 196 kg N ha^{-1} during 1999-2000. The increase in the dose by 8 kg N ha^{-1} during 1999-2000 was due to high grain yield owing to the favorable weather conditions particularly in the months of February and March. The quadratic function was used to estimate the optimum dose for nitrogen using price of 1 kg N, price of 1 kg wheat grain, price of 1.5 kg of wheat straw, coefficients "b" and "c" of the equations. It was observed that the optimum dose of nitrogen was 173 kg during 1998-99 and 183 kg during 1999-2000. Higher doses of nitrogen in the presence of FYM was due to the increased productivity of wheat crop coupled with more N loses under manured conditions. Increased N losses under manured conditions have been reported by several workers. The results of the soil test indicate that organic carbon, available P and K content increased due to FYM application. Available K content of the soil increased under manured conditions whereas, with the application of K fertilizer there is continuous depletion of available K. Thus manure application is must for maintaining K status of the soils.

Keywords: farmyard manure, wheat, nitrogen response, optimum dose

The role of soil properties, culture and fertilizers in change of fertility of degradated soils

NAZARYUK V.M., YAKUTINA O.P. and KLENOVA M.I.

Institute of Soil Sciense and Agrochemistry of Siberian branch of Russian Academy of Sciences, Novosibirsk, Russia

Degradation is one of the major factors resulting in essential reduction of soil fertility. On degradated soils grain yield is significantly reduced as the soil fertility is exhausted. In particular, on non-degradated leached Chernozem the yield of spring wheat cropped without application of fertilizers has practically remained without change in four years of rotation, and on weakly degradated analogue it has decreased by a factor of 3.1. The decrease in wheat productivity is first connected with the changes of the soil's nitric regime. Plants nutrition occurs at heat deficiency due to initial stocks of nitrate soil nitrogen and current mineralization of organic matter. In experiments the initial contents of nitrate nitrogen in non-degradated_and weakly degradated soils were similar i.e. 76-96 at the beginning of experiment and 30-37 mg kg^{-1} at the end of the third year respectively. The basic changes occur at the expense of current mineralization of organic substance of soil.

The agricultural cultures differently mobilize nitrogen of soil resources. For wheat, barley and oats, which have wide ratio C:N (>20) in overground phytomass, trash covering results in reducing the rate of nitrogen uptake. In the course of three rotation of model crop-rotation (9 years) at trash covering a tendency was observed to decrease the productivity of cereal crops and remove to nitrogen of phytomass approximately as much as 5%. It is connected with the prevalence of immobilization of soil nitrogen over its mobilization. To compensate the effect, the weak nitrogen-mobilizing ability of plants and the additional application of mineral nitric fertilizers is required.

For the cultivation of vegetable cultures, on the contrary, trash covering which is characteristic of narrow ratio C:N, results in increasing the productivity and as, consequence, increasing crop removal of soil nitrogen up to 12%.

The properties of soil play an impotent role in the mobilization of nitrogen in soil resources. For five years of realization of experience on leached Chernozem the productivity of grain cultures was higher by a factor of 1.4. than on soddy podzolic soil. Simultaneously with the increase of productivity of grain cultures nitrogen uptake from soil has raised. The plants used nitrogen on Chernozem by 42% more than on soddy podzolic soil.

The application of mineral fertilizers allows, under favorable hydrothermal conditions, to increase the yield of grain cultures by 69%, on soddy podzolic, grey forest soils 102% and leached Chernozem 21% respectively. Hence, using opportunities of culture and fertilizers it is possible appreciably to lower a role of processes of degradation and to increase thus sustainability of the functioning of the agroecosystem.

Keywords: fertility, arable soil, soil properties, nitrogen, phosphorus, potassium

Linking litter quality with decomposer functionality for a better understanding of plant litter mineralisation

NEERGAARD Andreas de and MAGID Jakob

Royal Veterinary and Agricultural University, Department of Agricultural Sciences, Thorvaldsensvej 40, DK-1871 Frederiksberg C, Denmark

We wished to study how nitrogen and substrate availability affected the decomposition of plant litters and the enzyme activity in the soil.

It has been demonstrated that in some cases higher nitrogen levels in soil slow down the decomposition of recalcitrant litters (reviewed in Fog 1988). In a laboratory study we incubated rape straw in soil and followed its decomposition for 200 days. Three main variables were tested: 1. Grounded or ungrounded plant material, 2. Plant litter mixed or stratified (layered) in the soil and 3. High or low mineral N content in the soil.

All three variables influenced the carbon mineralisation from the plant litter. Stratifying the plant litter, increasing soil N, and grinding the litter all led to lower carbon mineralisation rates. Contrary, the nitrogen immobilisation was larger in the treatments containing ground material, than in the ungrounded. Net nitrogen immobilisation was 3-4 times larger in the mixed treatments than in the stratified. It is suggested that the microbial biomass is better protected from predation when the plant litter is ground and mixed leading to larger immobilisation of nitrogen.

Future aspects of the study are discussed.

Keywords: litter quality, decomposer community, carbon mineralisation, enzyme activity, nitrogen availability

Precision chemical analysis of soils to support precision management decisions

OLNESS Alan (1), KUNZE Bruce (2), LIESER Michael (3), WEISER Hal (4) and RINKE Jana (1)

(1) USDA-ARS, N. Central Soil Conservation Res. Lab., Morris, MN 56267-1065, USA
(2) USDA- NRCS, Brookings, SD 57006-0626, USA
(3) USDA-NRCS, Fergus Falls, MN 56537-2505, USA
(4) USDA-NRCS, Jamestown, ND 58402-2096, USA

Technological advances in application of fertilizers and crop cultivars have expanded the potential for more precise management of soil. These advances are enhanced by careful mapping of soil resources and an evaluation of their physical and chemical attributes. Chemical characterization of soil by conventional methods is tedious, expensive and provides limited information. Resin-extraction of soils enables the simultaneous extraction of 20 or more readily exchangeable elements (Olness *et al*, 1990; Olness and Rinke, 1994) when the resin capacity is maintained as a fraction of the soil exchange capacity and neutral salts are used as exchange ions. Through use of this technique, Olness et al (1999, 2000, 2001 a, and b) were able to identify complex vanadium (V) interactions with phosphorus (P) and of magnesium (Mg) interactions with calcium (Ca) with plant genotypes of maize (*Zea mays* L.), soybean (*Glycine max* L.), and wheat (*Triticum aestivum* L.). Grain yield gains or losses of as much as 20% were associated with the specific soil exchangeable ions and either variety or hybrid. They were also able to show that soil mapping-units were distinguished easily by their suite of exchangeable ions.

Olness and Rinke (1999) were able to show distinct differences in the suite of resin-extractable elements between soils within a field. From these early observations, the question emerged as to whether or not units within a region maintained distinct profiles throughout the range of mapping units. Also, did chemical extractions obtained in one portion of a mapping region remain the same for soil mapping units in other portions of the region? If the resin-extractable characteristics associated with plant productivity remain stable throughout the region, then soil mapping can be used as an important tool in selecting soil management options for crop production. In order to address these questions, we examined the Barnes and Buse soils throughout their mapped region (170,000 km^2) in the Northern Great Plains.

Keywords: resin-extraction, phosphorus, calcium, sulfur, magnesium trace-elements

Soil fertility as an ecosystem concept

PALM Cheryl (1) and SWIFT Mike (2)

(1) 1015 King Drive, El Cerrito, California 94530, USA
(2) P.O. Box 30592, Nairobi, Kenya

The intention of this paper is to open debate on the selection of research priorities in soil fertility that is based on a framework in which the management of soil is approached from an ecosystem perspective. This ecosystem framework involves understanding the properties and processes within the soil, biota, and vegetation components as well as the interactions among them. There are underlying biogeochemical processes that describe the component processes and interactions among the ecosystem components; these processes can be quantified and thus the framework could serve as a basis for identification of the keystone properties and processes essential for maintaining the production and environmental functions of agroecosystems. The soil is seen as the integrator that determines many soil and ecosystem processes and functions. The first step for proposed approach is to identify key soil processes and properties that influence fertility and then to manipulate them through agroecosystem design. An agroecosystem is characterized by its vegetation – in terms of diversity, spatial and temporal arrangement and management. This design influences the quality of the organic inputs, composition and activity of the associated biota, the nutrient-use efficiency and net nutrient and energy balance of the system. A major research challenge is to determine the amounts and diversity of carbon inputs needed to maintain the soil biological system, including the key functional assemblage of biota, and component soil properties and functions. Once the links are known the challenge is to design and manage agroecosystems accordingly. Ultimately people are the key to sustained management or agroecosystems. The selection of agroecosytems by farmers is determined by their production goals and strongly influenced by experience, knowledge and culture. The target for research is to identify the set of agroecosystems that is possible within those human and environmental conditions that meet the joint aims of the production goals of the farmer and a sustained natural resource base.

Keywords: ecosystem, nutrient cycles, biodiversity, scale

Nitrogen management in a maize cover crop rotation

ROSOLEM C.A. and PACE L.

Dept. of Crop Science, College of Agricultural Sciences, São Paulo State University C.P. 237, 18603-970 Botucatu SP, Brazil

Conservation tillage and the use of cover crops are key factors to achieve sustainability in tropical agricultural systems. Considering N conservation a leguminous crop should be used as cover crop, but in tropical areas with dry winters there are no leguminous species able to grow well and develop a good mulch for the following crop. Some grasses such as black oats and pearl millet are suitable as cover crops, but in this case there is a strong competition with the following main crop for nitrogen. An experiment was conducted to evaluate the effect of non-conventional N management on a maize cover crop rotation in avoiding the deleterious effect of N competition. Black oats, pearl millet, white lupin, black oats fertilized with 60 kg ha^{-1} of N, pearl millet fertilized with 60 kg ha^{-1} of N, were grown during part of fall and winter. The next spring maize was planted without tillage in subplots receiving 0, 60 and 120 kg ha^{-1} of nitrogen. Soil, straw and plant samples were taken at 30 day intervals. The soil was sampled down to 60 cm deep. Most of the N released from the straw was found as nitrate and ammonium in the soil up to 60 days after maize emergence. The NO_3:NH_4 rate found in soil was around 1:1, and there was no effect of N management or cover crops. NO_3 and NH_4 contents in the soil down to 60 cm were uniform. After 60 days from maize emergence, the soil N declined as it was absorbed in considerable amounts by maize. Pearl millet and black oats were better than white lupin as catch crops for nitrogen, but there was a decrease in maize yields when it was cropped after these grasses without N fertilization. To avoid N competition when using black oat or pearl millet as cover crops before maize the N rate to be used must be split, applying half of the rate to the cover crop and the other half to maize.

Keywords: ammonium, conservation tillage, nitrate, no till, soil fertility, soil nitrogen

Modeling of the mineralization processes after manure fertilization in soil

ROSSITZA Mitovska and ZDRAVKA Petkova

N. Poushkarov Institute of Soil Science, 7 Shosse Bankya, Sofia-1080, Bulgaria

D.Kirham and W.Bartholomew (1954, 1955) are the first who had used the mathematical models for determination of mineralisation and immobilization rates upon the data obtained through the method. Simultaneous usage of ^{15}N dilution technique and mathematical modeling allowed to elucidate the essence of N transformation in soil and their dynamics. This is important for N nutrition of plants and creating of correct agrochemical management. The experiments are carried out using 2 soil types with contrasting properties - Leached Chernozem and Pseudopodzolic Cinnamon Forest Soil. Both laboratory experiments are three-factor ones, as the first factor in experiment A is mineral fertilisation with N, while in experiment B the first factor being fertilisation with P_2O_5 applied in two levels: 0 and 0.2 g kg^{-1} soil. The second factor is manure with five levels of variation for creating different C:P ratio, namely 45, 30 and 15. The third factor is humidity in two levels - 40 and 80% of the water holding capacity (WHC). Experimental results showed that the highest quantity of NH_4-N is measured in compost with Leached Chernozem 2 weeks after manure application. The same regularity is established also in compost with the second soil type. Nitrification processes run with bigger rates during the first 2 weeks. The highest quantity of NH_4, NH_2 and NO_3 is accumulated in compost where C:N ratio is 10 and 20 and the lowest - where C:N ratio is 30 and 40. Nitrification processes run more rapidly in 80% humidity but amonification processes - in 40%. In compost with Pseudopodzolic Cinnamon Forest Soil the mineral N fertilisation do not accelerate mineralisation of organic matter in comparison with Leached Chernozem. During the composting of manure and superphosphate in this soil there is observed to be a negligible NH_4-N quantity. The nitrification runs most intensively in compost with C:P ratio 45 during 2 months. The quantity of mineral N is decreased with the increasing of composting period. The quantity of mineral N is decreased also with the decreasing of C:P ratio while with C:N ratio the situation is opposite. In the composts with the second soil type the content of NO_3-N is increased with the increasing of the composting period. It is observed more intensive mineralisation in the treatments with C:P ratio - 45 and 30 in comparison with the different C:N ratio. The data of the experiments A and B is processed applying the dispersion analysis method. This method allowed to determine which controllable factors (mineral fertilizing with N and P, soil humidity and time) affect significantly the transformation of the organic N compounds in soil after application of organic matter. Having in mind the disadvantages of the empirical models received for NH_4, NH_2 and NO_3 the following semiempirical model is proposed for the experiments A and B: $Y = b_0 + b_1*n + b_2*org + b_3*(H-40)*exp(b_4*t)log(b_5*t)$, where Y is the amount of NH_4, NH_2 and NO_3; n - the nitrogen applied; org - the applied organic substances; H%- humidity; t- time of sampling. This model has the advantage that its parameters allow an interpretation rich in content. For example the b_0 coefficient is the initial amount of nitrogen in the soil; b_1 is the change after the mineral fertilizer application; b_2 - the change after application of organic substances; b_3 - the influence of humidity. The $exp(b_4*t)$ term determines the immobilization and the $log(b_5*t)$ - nitrification. The empirical and semiempirical models obtained allow as to estimate quantitatively the processes of mineralisation in soil, conducting to NH_4, NH_2 and NO_3 formation and nitrogen assimilation by plants after manure application through the indices yield and nitrogen uptake. To the main conclusions should be added that the C:N ratio 20:1 is optimal for Leached Chernozem, while for Pseudopodzolic Cinnamon Forest Soil it is 10:1. The mineralisation of organic N increases during the first 2-8 weeks, reaches minimum towards the 16th week and then reaches a certain level towards the 48th week.

Keywords: ^{15}N dilution technique, N transformation, manure fertilization

Tillage, liming, and straw management effects on N cycling in an acid soil

SOON Y.K. and ARSHAD M.A.

Agriculture and Agri-Food Canada, P. O. Box 29, Beaverlodge, AB, T0H 0C0, Canada

We investigated the effects and interactions of tillage, liming and crop residue removal on inorganic and microbial biomass N, and N uptake of crops grown in rotation in an acid soil from 1998 to 2000. The experimental treatments were factorial combinations of no-till (NT) or conventional tillage (CT), unlimed (soil pH 5.0 in 0.01 M $CaCl_2$) or limed (7.5 t ha^{-1}, pH 5.9), and straw removed or retained. The crop rotation was a barley-canola-field pea sequence, with all phases grown every year. Nitrate content in the surface soil at seeding was increased by NT compared to CT only in unlimed soil, whereas soil microbial N during crop growth was increased under NT in the limed soil only. Straw retention decreased soil nitrate at seeding and increased soil microbial N. However, soil management effects on soil N stock were not significant every year. Crop yield and N uptake was increased by liming, and by NT as compared to CT. However, the yield and N uptake differences due to tillage systems were significant only in the limed soil, i.e., followed the trend shown for soil microbial N. Crop residue effect on yield and N uptake was small and not significant. N cycling over the study period was not affected by straw management. The partitioning of plant N from different sources in the soil was influenced only by the cropping sequence.

Keywords: N cycling, crop rotation, legume, liming, straw management, tillage

Effect of the levels of saturation for bases of soils in the uptake and available of nutrients in coffee tree

SOUZA Luiz Humberto, SOUZA José Olimpio de Jr., CARNICELLI José Humberto de Araujo, MELO FILHO José Fernandes, CARVALHO Gilberto Santana and OLIVEIRA Carlos Alberto Costa

UESB - DFZ, Cx. Postal 95, 45100-000, Vitória da Conquista, Bahia, Brazil

Acid soils occupy about 30% (3.95 b ha^{-1}) of the world's ice-free land area. Plant growth-limiting factores in acid soils include deficiencies (N, P, Ca, Mg, Zn) and toxicities (Al, Mn, Fe, H) of elements (Foy, 1984). The efficiency of added fertilizers is very low in acid soils. The integrated plant nutrient management system is important to improve crop yield potentials in acid, infertile soils. In tropical South America, 85% of the soils are acidic and approximately 850 m ha^{-1} of under-utilized acid soils exist in this region. The objective of that work was to determine values of saturation of ideal bases, for the tree coffee, for soils with different textures and sources of acidity (H and Al). The experiment was formed by 4 soils (Table 1) and 5 saturation levels for bases (natural soil, 30%, 50%, 70% and 90%), with randomized in blocks to the maybe and with 4 repetitions. The change induced in the levels of saturation for bases of soils to get at liming, affected the uptake of nutrients of the tree coffee. P, K, S, B, Mn and Zn in sand soils and N, K and S in clay soils. The amount of K, Cu, Mn and Zn available, increased at V= 33% in media, on application of the 2.5 t ha^{-1} in pot. Increase two time the liming in the field. Probably in sand soils this dose is low.

Table 1 Mean values for four tropical soils acids characteristics (0-20 cm)

Soils	pH[1]	P[2]	S[3]	K[2]	Al[4]	V	B[2]	Fe[2]	Mn[5]	Cu[2]	Zn[2]	clay	sand
		mg	dm^{-3}	$mmol_c$	dm^{-3}	%	------------ mg	dm^{-3}	---------		------- g	kg^{-1}	------
LA UESB	4.3	2	34	0.7	19	4.5	0.3	68	1	0.9	0.9	315	577
LA EBDA	4.6	1	27	0.9	18	15.3	0.3	108	4	0.7	0.9	354	443
LV Palmira	4.2	1	79	1.3	11	9.8	0.6	96	1	1.7	1.0	451	285
LA Limeira	4.2	2	48	1.4	23	9.2	0.4	76	2	0.9	0.5	538	311

[1] Relation soil : water 1:2.5; [2] Mehlich-1; [3] $CaHPO_4.H_2O$; [4] KCl 1 mol L^{-1}; [5] Hot water.

Foy, C.D. 1984. Physiological effects of hidrogen, aluminum and manganese toxicities in acid soils. pp.57-97. *In* F. Adams (ed.). Soil Acidity and Liming. Am. Soc. Agron., Madison.

Keywords: coffee, acid soils, uptake nutrients

Transformation of superphosphate in calcareous Chernozem

TSIGANOK V.D. and ANDRIESH S.V.

Moldavian Institute of Pedology, Agrochemistry and Hidrology, 2070, Kishinev, street Ialoveni, 100, Institute of Pedology, Agrochemistry and Hidrology, Republic Moldova

Calcareous chernozems in Republic Moldova contain in the ploughed layer 2.5-3.5% of humus, 1-4% $CaCO_3$. Generally they have heavy loam texture. Phosphorus nutritive regime of long-term cultivated unfertilized soils is forming mostly on account of humus decomposition. It provides near 10 kg P ha^{-1} annually. Participation of soil mineral fraction in the forming of the available phosphorus reserve is about 1 kg ha^{-1} y^{-1}. In multiannual cycle stabile reserve of labile phosphorus is forming around 90 kg P ha^{-1}. Content of labile P in not fertilized chernozems is 0.6 mg kg^{-1} in the ploughed layer and diminishes to 0.3 mg kg^{-1} at a depth of 60-80 cm, according to Olsen's method. Such poor phosphorus nutritive level is enough to get yields of winter wheat and maize 2.4 and 3.5 t ha^{-1}. Average annual rainfall 450-500 mm allows to increase production to 50-60%. For such yields content of labile phosphorus according to Olsen's method must be 1.5-1.7 mg kg^{-1}. This level can be reached by an annual systematical fertilizer rate P30.

In laboratory and field experiments authors have got next information about solubility of compounds formed in the process of interaction between granulated superphosphate (7% water soluble P) and calcareous chernozem. New formed phosphates distributed in 1% volume of fertilized soil. In layers remoted from granules to 0-2, 2-3 and 3-4 mm, 5130, 1480 and 610 mg kg^{-1} P precipitated. After 6 months interaction about 59% of precipitated phosphates corresponded to solubility product of $CaHPO_4$. All precipitated compounds were soluble in repeated extracts with 0.5 N $NaHCO_3$. The size of the reaction zone was constant during the 3 years. The processes of diffusion and washing away were slight, phosphorus almost did not migrate in the surrounding soil. Small reaction zones shrinked into themselves, future transformations elapsed directly there.

In laboratory conditions where humidity and temperature of soil were 20% and 20-30°C, new formed phosphates after 17 months transformed in less soluble salts intermediated between octacalcium phosphate and apatite. Amond them 65% were not extracted in 0.5 N $NaHCO_3$. In field more arid conditions the process of phosphorus aging was slower by almost twice. About 20% of applied phosphorus corresponded to solubility of $CaHPO_4$ after 3 years, 20% transformed in compounds which were not dissolved in 0.5 N $NaHCO_3$.

Keywords: superphosphate, soil, interaction, distribution, solubility

Phosphorus loss from grassland soils to water

TUNNEY Hubert, DALY Karen and KURZ Isabelle

Teagasc, Johnstown Castle Research Centre, Wexford, Ireland

In Ireland about half the phosphorus (P) loss to water is from agricultural sources and has increased significantly over the past 50 years. National and European Union policy and legislation aim at reducing P loss to water in order to reduce eutrophication. In Ireland, the average soil test P has increased ten fold, from less than 1 to over 8 mg P L^{-1} soil, over the past 50 years. In the region 90% of the agricultural area (4 million ha) is grassland. Results of work on soil P dynamics in 1? Irish soils and on the loss of P in overland flow from four field sites are presented. Soil P desorption, using three methods, depended on soil P test (STP). Soil P sorption correlated negatively with soil organic matter (OM) indicating that OM may inhibit adsorption from solution to soil. There is strong evidence of a washout effect of P when overland flow starts in the autumn. The high P concentrations at the start of the overland flow season decreased several fold over the first two months and stabilised at a lower level until the end of the main overland flow period in March. The dissolved reactive P (DRP) concentration in overland flow varies from below the detection limit (0.005 mg L^{-1}) to over 6.0 mg L^{-1}. The DRP losses were from <0.5 to >4.0 kg ha^{-1} per year. In the region of 75% of total P loss is present as DRP, which is considered to be mainly orthophosphate. During heavy rainfall periods the DRP concentration increases with the increasing limb and decreases with the decreasing limb of the hydrograph. Therefore, much of the P load (concentration by volume) to water occurs in relatively short periods during less than 20 days of the year. The results indicated a positive relationship between STP and dissolved reactive P (DRP) in water from the four grazed grassland fields and are in good agreement with four studies from the literature. The equation of best fit for the five studies was: DRP = $0.002(STP)^2$, with R^2 = 0.92. The results indicate that water quality and grassland production are compatible. However, for good water quality it appears that STP should be at or near the lower end of the range for optimum grassland production.

Keywords: phosphorus, water, soil, grassland, eutrophication, agriculture

Determining temperature coefficients for soil organic nitrogen mineralization using TDR

DE NEVE Stefaan, HOFMAN Georges and HARTMANN Roger

University of Gent, Department of Soil Management and Soil Care, Coupure Links 653, 9000 Gent, Belgium

We have used the TDR's ability of directly measuring electrical conductivity of the bulk soil σ_a, to determine the temperature dependence of N mineralization from soil organic matter in a loamy sand soil, and have compared this to actual measurements of the temperature dependence of N mineralization. Calibration measurements were made with different amounts of KNO_3 at different soil moisture contents to calculate the electrical conductivity σ_w of the soil solution from the bulk electrical conductivity σ_a and the moisture content θ. The actual σ_w was determined from the conductivity of 1:2 soil:water extracts ($\sigma_{1:2}$) with a mass balance approach using measured NO_3^- concentrations. Using the paired combinations of σ_a, σ_w and θ, the parameters of the Rhoades electrical conductivity model were estimated. Mineralization of N was measured during laboratory incubations at six temperatures and also monitored using TDR. Zero order rate constants for measured N mineralization ranged from 0.164 at 5.5°C to 0.865 mg N kg^{-1} soil day^{-1} at 30°C, respectively. Zero order mineralization rate constants k for TDR calculated NO_3^- concentrations varied between 0.070 (at 5.5°C) and 0.734 mg N kg^{-1} soil day^{-1} (at 30°C), which were slightly smaller, but in the same range, as the measured values. Underestimation of the measured NO_3^- concentrations by TDR was due, at least partially, to differences in cation composition of the soil solution between calibration and mineralization experiment. A temperature dependence model for N mineralization from soil organic matter was fitted to both the measured and the TDR calculated mineralization rates, k and k_{TDR}, respectively. There were no significant differences between the model parameters based on measured and TDR calculated data. The results obtained here were promising for further use of TDR to monitor soil organic N mineralization.

Keywords: N mineralization, electrical conductivity, TDR, temperature

Determining critical nitrogen application rates to reduce nitrate leaching in dairy pastures

DI Hong J. and CAMERON Keith C.

Centre for Soil and Environmental Quality, Lincoln University, Canterbury, New Zealand

Over the past decade, there has been a rapid increase in dairy farming in New Zealand. Nitrate leaching from intensive agricultural systems, e.g. dairy farms, is considered a major contributor to increased nitrate concentrations in ground and surface waters. The objective of this research programme was to determine nitrate leaching losses on dairy pasture systems as affected by the application of dairy shed effluent (DSE), nitrogen (N) fertilizers and cow urine on free-draining soils using large, undisturbed soil lysimeters. The data obtained were used to develop a simple, semi-empirical computer model to estimate nitrate leaching losses and critical N application rates to minimize nitrate leaching.

Undisturbed soil monolith lysimeters (50-80 cm diameter and 70-120 cm depth) were collected from a free-draining Templeton fine sandy loam (*Immature Pallic soil; Haplustepts*) and were installed to a field lysimeter laboratory. N leaching losses were measured after the application of urea, ammonium chloride, DSE, and/or cow urine. The data obtained were then used to develop a simple, semi-empirical management model to estimate N leaching losses and critical N application rates.

The nitrogen leaching estimation (NLE) model is based on the concept that the annual N leaching loss is related to the annual average amount of potentially leachable N (mineral N and mineralizabe N) in the soil, and the annual drainage. The potentially leachable N (N_{PL}) is determined by the sum of annual fluxes of N cycling processes including atmospheric N deposition (N_{AD}); fertilizer or effluent N application rate (N_F); biological N fixation (N_B); net N mineralization (N_M); animal N returns (mainly urine) to the pastures (N_A); pasture N uptake (N_P); volatilization losses after the application of N fertilizers or effluents (N_V); and denitrification loss (N_D) (Eqn 1) (kg N ha^{-1}).

$$N_{PL} = N_{AD} + N_F + N_B + N_M + N_A - N_P - N_V - N_D \quad (1)$$

The relationship between nitrate leaching and N_{PL} was established on the basis of the data obtained from the lysimeter studies.

The NLE model estimated that the critical N application rates (above which the NO_3-N concentration in the drainage water will exceed 11.3 mg NO_3-N L^{-1}) for grazed pasture systems (with urine input) were 160-200 kg N ha^{-1} y^{-1} if urea was applied, or 250-300 kg N ha^{-1} if dairy shed effluent was applied. For cut pastures (i.e.no urine input), the critical application rates were about 400 for urea, and 600 for DSE.

Keywords: nitrogen, leaching, cycling, denitrification, grassland, nitrate

Biodiversity of *Azospirillum* in Ornamental Rhizoshpere Soils of Karnataka

RAVI S. GADAGI[1], KRISHNARAJ, P.U[2]., KULKARNI, J.H[2]. AND TONGMIN SA[1]

[1]Dept. of Agricultural Chemistry, Chungbuk National Univ., Cheongju, 361-763, Korea

[2]Dept. of Agricultural Microbiology, Univ. of Agricultural Sciences, Dharwad, 580 005, Karnataka, India

The biodiversity of *Azospirillum* with respect to ornamental plants grown in different agroclimatic regions of Karnataka, India, was investigated in the present study. Different locations representing flower-growing areas, where flower cultivation has taken on a large scale for over a period of time, were selected for isolating *Azospirillum* spp. By using the enrichment culture technique, *Azospirillum* isolates were obtained from soil and root tissue of different ornamental flower plants. Eight eight *Azospirillum* strains were isolated from the 15 different families of plant species, which are grown in different agro ecological regions of Karnataka. Their cultural and biochemical characteristics indicated that 55.06 percent was *Azospirillum lipoferum* and 41.57 per cent *Azospirillum brasilense*. The rest of the isolates showed properties, which were atypical of the recognized species. The *Azospirillum* isolates of the ornamental plants varied in their ability to fix atmospheric nitrogen. The highest ARA and dinitrogen fixed $g^{-1}$of malate was recorded in *Azospirillum* isolate OAD-2, which was isolated from *Gaillardia pulchella*. *In vitro* synthesis of IAA and GA by the 88 *Azospirillum* isolates and four reference strains was examined on medium with tryptone as precursor. All *Azospirillum* isolates were screened under green house condition using *Gaillardia pulchella* as test plant to select efficient strains for inoculating the *Gaillardia pulchella* and other ornamental plants. The study indicated that maximum plant height, biomass and N-uptake was observed in plants inoculated with OAD-2, OAD-3, OAD-9, OAD-11, OAD-29, OAD-37 and OAD-57, when compared to other inoculated plants and / or uninoculated control plants. From the present investigation, it is concluded that *Azospirillum* also harbours 15 families of plant species apart from graminaceace. The isolate OAD-2 proved to be best in N_2 fixation, among also other isolates. Also, it is interesting to note that strains OAD-57 produced the highest both plant growth promoting substances (IAA and GA). This can impact on beneficial activities of this organism to ornamental plants for augmenting their crop productivity.

BACKGROUND AND OBJECTIVES

Biological nitrogen fixers offer economically attractive and ecologically sound means of reducing external N inputs and improving the quality of internal resources.

Among the various free living nitrogen fixing bacteria, *Azospirillum* is dominant in nitrogen fixing ability.

The associations of *Azospirillum* spp. were initially reported to be restricted to the graminaceace (Dobeirner and Day, 1976)

However, there have been many reports on the association of these organisms with roots of other plants (Laxmikumari *et al.*, 1976; Kumar *et al.*, 1995; and Baldani, *et al.*, 1997)

Although the growth and physiology of the *Azospirillum* culture isolated from forage grasses studied by several workers (Day and Dobeirner, 1976 and Nur *et al.*, 1980), not much information is available on the isolates from ornamental plants and their possible role in the N economy of these plants.

Hence, present investigation carried to know the occurrence of *Azospirillum* spp in the ornamental plant and their possible use as biofertilizers for ornamental plants.

MATERIALS AND METHODS

Isolation : Enrichment culture technique as described by Day and Dobeirner (1976).

Plants : The roots of the different ornamental plants were collected from the field throughout Karnataka.

Identification : In comparison with reference strains of *Azospirillum brasilense* BR-11001 and *Azospirillum lipoferum* BR-11080 (obtained from Embrapa, Brazil.) and according to the Bergey's manual of systemic bacteriology (Kreig And Dobeirner 1984).

Nitrogen fixation : Acetyelene reduction assay (ARA) : Hardy *et al.*, (1968) method
MicroKjeldhal : Humphries (1956) Method

Indole acetic acid : Tien *et al* (1979); **Gibberllic acid production** : Paleg (1965)

All Evaluation of *Azospirillum* isolates for plant growth promotion and nitrogen fixation under green house condition.
The soil : soil of Agricultural farm, UAS, Dharwad. One kg capacity pots were filled with autoclaved sand: soil mixture (1:1).
Fertilizers : SSP; 80, MOP; 75 kg ha^{-1}, No N. **Seeds** : *Gaillardia pulchella* var picta DGS-I.
Inoculum : All 88 isolates were cultured in NH_4-malate liquid media. Standard inoculums (10^7 CFU ml^{-1}) of each isolates inoculated to each pot.

Six weeks after plant growth, all the plants were harvested. Plant samples were oven dried at 80 °C for 48 h. Total N was estimated by modified Kjeldahal method.

IMPORTANT FINDINGS

Azospirillum strains isolated from roots of ornamental plants based on their morphological characteristic they were as followed.

Subsurface pellicle in semisolid media (Fig. 1A)
Pink colony on BMS potato agar (Fig. 1B)
Scarlet colony on Congo red media (Fig. 1C)

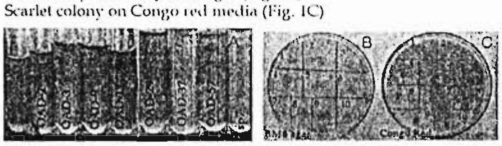

Fig. 1. Morphological characteristics of selected *Azospirillum* isolates on semisolid (A), BMS(B), Congo red (C) media.

Eighty-eight *Azospirillum* strains were isolated from the roots of 15 different families of ornamental plant species from various agro- ecological regions of Karnataka (Table 1).

Table 1. ..1 *Ao spirillum* strains isolated from different families and plant species

Families	Plant Species	Isolates	Families	Plant Species	Isolates
Asteraceae	*Gaillardia pulchella*	OAD-1-10,12	Amarllidae	Tuberose	OAD-54-56
	Chrysanthemum	OAD-11,13-20	Polemoniceae	Phlox	OAD-59
	Chinaster	OAD-21-24	Apocyanaceae	Madagskar	OAD-60-63
	Marigold	OAD-38-43	Balsaminaea	Balsam	OAD-64
	Pot marigold	OAD-57-58	Amarthanceae	Coxcomb	OAD-67-70
	Zinnea	OAD-72-73		Bachelar's button	OAD-85
	Gerbera	OAD-74-77	Rubbacea	Ixora	OAD-71
	Cosmos	OAD-65-66	Euphorbiacea	Money plant	OAD-79
	Philodendron	OAD-78		Duranta	OAD-80
Iridacea	Sward lily	OAD-25-30		Croton	OAD-81
Rosaceae	Rose	OAD-31-37	Solaneeace	Sweet Potato	OAD-83-84
Apocyanacea	Jasmine	OAD-44-47	Canaceae	Indian Shot	OAD-85
Acanthancea	Crossadra	OAD-48-50	Caryophyllae	Cornation	OAD-86-88

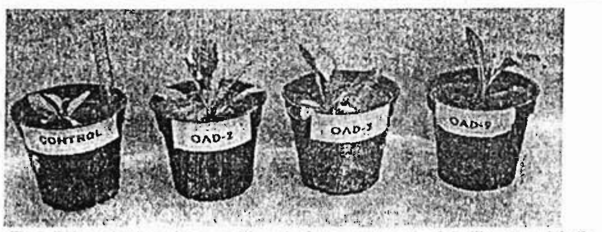

Fig.2. Effect of selected *Ao spirillum* isolates on growth of *Gaillardia pulchella* under green house condition

The physiological characters revealed the successful isolation of *Azospirillum* strains from ornamental plants (Table 2).

Table 2. Tentative identification *Ao spirillum* isolates from ornamental plants

Isolate No.	Utilization of carbon sources: Malate	Succinate	Lactate	Glucose	Keto glutarate	Mannitol	Sucrose	Acidification of Glucose peptone broth	Biotin requirement	Tentative identification
Group I	•	•	•			•				*A. Brasilens*
Group II	•	•	•	•	•	•		•	•	*A. Lipoferum*
OAD-24	•	•	•	•		•			-	Unidentified
OAD-25	•	•	•			•			-	Unidentified
OAD-26	•	•	•			•	•		-	Unidentified

Group I : OAD-1,-2,-3,-4,-5,-6,-10, -18,-19,-21, -22,-23,-29,-33,-34,-38, -39,-40,-41, -44, -51,-53,-55,-57 -82,-83, 84,-85,

Group II : OAD-7, 8,-9,-11,--12,-13,-14,-15,-16, -17,-20,-27,-28,-30,-31,-32,-36,-37,-42, -43,-45, 46,-47,-48,-49,-50,-52,-54,-75, -76, -77, -78,-79,-80,-81,-82,-86, 87, 88, -89

Beneficial traits of *Azospirillum* isolates as followed in Table 3.

Table 3. Beneficial traits of *Ao spirillum* isolates from ornamental plants

Isolates No.	N-fixed mg g^{-1} malate	ARA (n mole g^{-1} protein)	IAA ug $100 ml^{-1}$	GA ug $25ml^{-1}$
OAD-2	20.54	191.41	29.50	2.25
OAD-3	17.50	152.86	28.14	1.20
OAD-9	17.50	142.86	32.12	2.12
OAD-11	19.44	180.97	25.36	4.23
OAD-29	17.50	147.51	24.36	2.15
OAD-37	19.88	163.70	14.00	0.14
OAD-57	14.00	--	38.12	4.23
LSD0.05	2.75	--	3.45	1.12

Data-mean of 5 replications

Table 4. Effect of *Ao spirillum* isolates on *Gaillardia pulchella* under green house

Isolates No.	Shoot length (cm)	Root length (cm)	Biomass $plant^{-1}$ (g)	N-uptake (mg $plant^{-1}$)
OAD-2	7.1	8.8	1.12	9.80
OAD-3	5.0	7.7	0.96	7.60
OAD-9	7.1	8.3	0.89	7.80
OAD-11	4.1	8.7	1.06	9.60
OAD-29	5.0	6.6	0.48	2.88
OAD-37	5.0	8.2	0.91	9.00
OAD-57	7.1	8.0	0.79	6.54
LSD0.05	1.1	0.2	0.21	0.56

Data-mean of 5 replications

The *Azospirillum* inoculated plants showed dry mass, shoot length (Fig. 2) and nitrogen uptake than that of uninoculated control plants (Table 4).

CONCLUSION

1. We confirmed the *Azospirillum* existence in the rhizosphere of ornamental plant families apart from graminaceace.
2. The ARA of the *Azospirillum* isolates ranged from 40.05 (*Azospirillum* strain OAD-24) to 195.41 η moles g^{-1} protein h^{-1} (*Azospirillum* strain OAD-2).
3. Indole acetic acid production was ranged from 1.12 (*Azospirillum* strain OAD-75) to 38.2 ug 100 ml^{-1} (*Azospirillum* strain OAD-57).
4. The *Azospirillum* isolates OAD-2, OAD-3 and OAD-9 were found to be efficient in nitrogen fixation and plant growth promotion of *Gaillarida pulchella* under green house condition.

GOBIERNO DE CHILE
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PROGRAMA DE FORMACIÓN PARA LA INNOVACIÓN AGRARIA

APOYO A LA PARTICIPACIÓN EN ACTIVIDADES DE FORMACIÓN

17TH CONGRESO MUNDIAL DE LA CIENCIA DEL SUELO
Agosto 2002, Bangkok, Thailandia
ENFRENTANDO LA NUEVA REALIDAD DEL SIGLO 21

INFORME DE DIFUSION
Código FIA-FP-V-2002-1-A-33

Diciembre 2002

GOBIERNO DE CHILE
FUNDACION PARA LA
INNOVACIÓN AGRARIA

INFORME DE DIFUSIÓN

PROGRAMA FORMACION PARA LA PARTICIPACION

1 Nombre de la propuesta :

Actualización y Captura de Información Científico tecnológica en el área de la fertilidad de suelos y Producción de semilla: 17° Congreso Mundial de las Ciencias del Suelo

1.1 Modalidad

Encuentro Científico

1.2 Lugar donde se llevo a cabo la formación

Bangkok - Thailandia

1.3 Rubro / Area temática de la actividad de formación

Rubro: Fertilización y Producción de semilla

Tema: Manejo de la fertilización en producción de semilla de Trébol rosado (*Trifolium pratense*)

1.4 Fecha en la que se efectúo la actividad de formación:

Inicio : 14 de Agosto de 2002

Término: 21 de Agosto de 2002

1.5 Postulante

Rolando Demanet Filippi

1.6 Entidad Responsable

International Society of Soil Science. Página Web: 17wcss.ku.ac.th

1.7 Coordinador

Sampong Theera Wong. President of the Congress

1.8 Identificación de los participantes de la propuesta

NOMBRE	RUT	TELEFONO FAX E-MAIL	DIRECCION POSTAL	ACTIVIDAD PRINCIPAL
Rolando Demanet Filippi		Fono 045-325450 FAX 045-325453 rdemanet@ufro.cl	Avenida Francisco Salazar 01145, Casilla 54-D Temuco.	Profesor

2. ACTIVIDADES DE TRASFERENCIA

2.1. Resumen actividades de transferencia PROPUESTAS

FECHA	ACTIVIDAD	OBJETIVO	LUGAR	Nº y TIPO BENEFICIARIOS
Septiembre de 2002	Presentación Oral	Exposición y discusión de los avances científicos y tecnológicos en el área de la nutrición vegetal y fertilización de especies forrajeras	Instituto de Agroindustria, Universidad de la Frontera, Temuco	Equipo técnico de las empresas multiplicadoras de semillas forrajeras 8 – 22 personas
Octubre 2002	Artículo Técnico divulgativo en revista Frontera Agrícola	Producción de semilla de Trébol rosado.	Revista Frontera Agrícola	1.000 ejemplares de tiraje normal. Esta revista se entrega por canje a bibliotecas, asesores, técnicos y profesionales del área agropecuaria

2.1. Resumen actividades de trasferencia REALIZADAS

FECHA	ACTIVIDAD	OBJETIVO	LUGAR	Nº y TIPO BENEFICIARIOS
19 de Noviembre de 2002	Presentación oral "Avances en Nutrición Vegetal y Fertilización de Especies Forrajeras"	Divulgar los principales avances logrados en el área de la nutrición de plantas forrajeras de interés para la zona sur del país.	Instituto de Agroindustria, Universidad de la Frontera, Temuco	Profesionales de empresas multiplicadoras de semillas, comercializadoras de fertilizantes y asesores técnicos del área.
21 de Noviembre	Conferencia "Efecto de la Fertilización y manejo en la producción de trébol rosado en suelos volcánicos"	Exposición y discusión con estudias de post grado y tesistas de pregrado en los avances del manejo técnico de trébol rosado en suelos volcánicos.	Instituto de Agroindustria, Universidad de la Frontera, Temuco	Estudiantes de post grado y alumnos tesistas de agronomía.
Noviembre 2002	Elaboración de artículo técnico	Manejo de semilleros de trébol rosado	Revista Frontera Agrícola	1.000 ejemplares de tiraje normal. Esta revista se entrega por canje a bibliotecas, asesores, técnicos y profesionales del área agropecuaria

2.2. Detalle por actividad de transferencia REALIZADAS

Fecha 19 de Noviembre de 2002

Lugar (Ciudad e Institución) Temuco, Instituto de Agroindustria – Universidad de La Frontera

Actividad (en este punto explicar con detalle la actividad realizada y mencionar la información entregada)

Charla a profesionales y productores agrícolas realizada el día martes 19 de Noviembre en el auditórium del Instituto de Agroindustria de la Universidad de La Frontera. En esta actividad se presentaron tres exposiciones de los profesionales participantes en el 17 Congreso mundial de la Ciencias del Suelo. Dra. María de la Luz Mora G. con el tema "Una visión moderna del concepto de fertilidad de suelos y uso de fertilizantes; Dr. Fernando Borie B. que presentó "Potencialidades de los Biofertilizantes" y Rolando Demanet F. "Avances en Nutrición vegetal y fertilización de especies forrajeras" El contenido de la charla se adjunta.

Fecha 21 de Noviembre de 2002

Lugar (Ciudad e Institución) Temuco, Instituto de Agroindustria de la Universidad de La Frontera

Actividad (en este punto explicar con detalle la actividad realizada y mencionar la información entregada)

Conferencia dictada por los profesores que asistieron al 17° Congreso Mundial de la Ciencia del suelo a estudiantes de doctorado y alumnos tesistas y de ultimo año de Agronomía. Se presentaron tres conferencias: " Influencia de los tipos de nitrógeno fertilizante en la nutrición mineral del Trigo y Micorrizas (Dr. Fernando Borie B.). "Efecto de la fertilización y manejo en la producción de trébol rosado en suelos volcánicos" (Ing. Agr. Rolando demanet F.). "Efecto de la materia orgánica y las propiedades de suelos volcánicos sobre la adsorción de sulfatos" (Dr. María de Luz Mora G.). El contenido de la conferencia se adjunta.

Fecha Noviembre 2002

Lugar (Ciudad e Institución) Temuco, Instituto de Agroindustria de la Universidad de La Frontera

Actividad (en este punto explicar con detalle la actividad realizada y mencionar la información entregada)

Elaboración de un artículo técnico relacionado con la producción de semilla de trébol rosado. Este fue presentado al comité editor de la Revista Frontera Agrícola que edita nuestra Universidad y que tiene un tiraje de 1.000 ejemplares.

2.2. Especificar el grado de éxito de las actividades propuestas, dando razones de los problemas presentados y sugerencias para mejorar.

En la región existe siempre gran interés por el equipo tévcnico de las empresas por conocer los avances en el cultivo de trébol rosado. Se debe considerar que anualmente se establecen 5.000 ha de esta especie para producción de semilla y forraje. La discusión se centró en el incremento de los rendimientos que se pueden alcanzar en producción de semilla y forraje con un manejo adecuado de la fertilización y riego.

Los estudiantes de post grado y pregrado presentaron gran interés por el conocimiento del manejo del trébol rosado en suelos volcánicos, esn especial, lo referente al manejo de micronutrientes, dado que en esta área existe un gran numero de alumnos trabajando en este tema.

El éxito de la publicación no se puede cuantificar dado que esta en proceso de evaluación por el comité editor de la revista Frontera Agrícola.

2.3. Listado de documentos o materiales mostrados en las actividades y entregados a los asistentes (escrito y/o visual). (Se debe adjuntar una copia del material)

Tipo de material	Nombre o identificación	Idioma	Cantidad
Presentación Power Point	"Avances en Nutrición vegetal y Fertilización de especies forrajeras"	Español	1
Presentación Power Point	"Efecto de la Fertilización y manejo en la producción de trébol rosado en suelos volcánicos"	Español	1
Artículo Técnico	Producción de semilla de Trébol rosado	Español	1000 ejemplares

3. ASPECTOS ADMINISTRATIVOS

Indicar los problemas administrativos que surgieron en la preparación y realización de las actividades de difusión.

Se debieron postergar las actividades de difusión, debido a los diversos compromisos que se tienen en las actividades académicas de la Universidad
La publicación del artículo técnico esta sujeto a la aprobación del comité editor de la Revista Frontera Agrícola.

Fecha: 6 de Diciembre de 2002

Firma responsable de la ejecución:

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INSTITUTO
AGROINDUSTRIA

INVITACIÓN A CHARLAS PARA PROFESIONALES Y PRODUCTORES AGRÍCOLAS

Como parte de las

Actividades de Difusión del Programa de Formación para la Innovación Agraria

(FIA)

GOBIERNO DE CHILE
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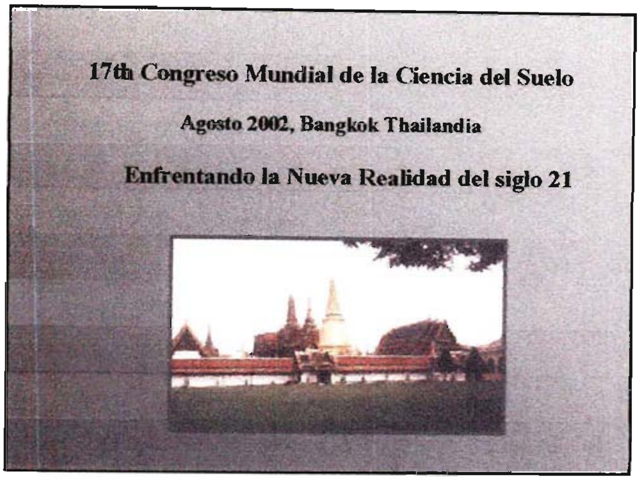
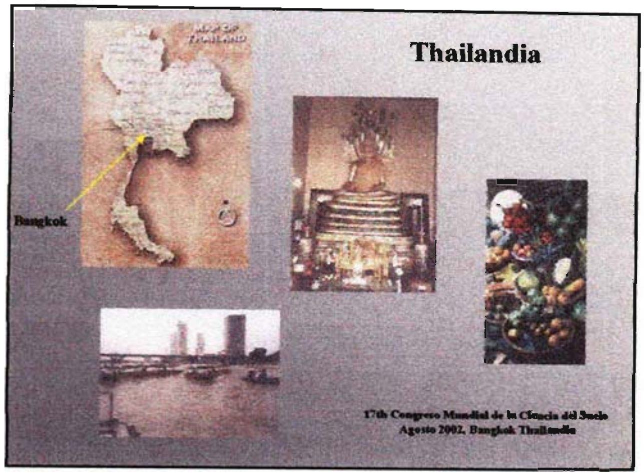
INSTITUTO
AGROINDUSTRIA

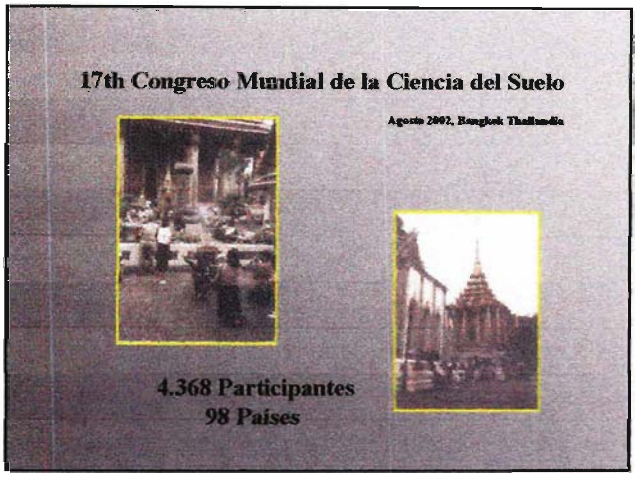
Programa

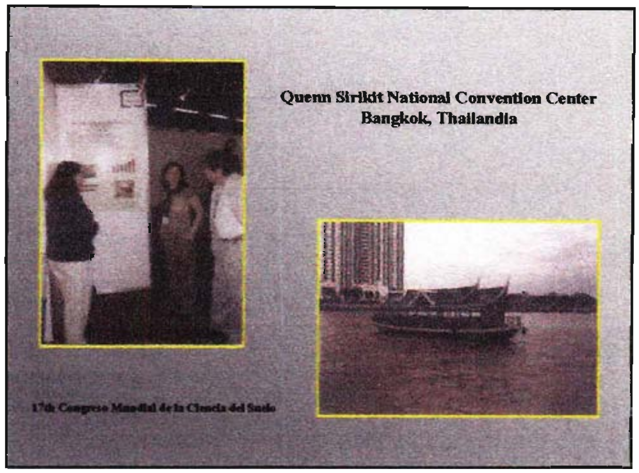
Martes 19 de Noviembre

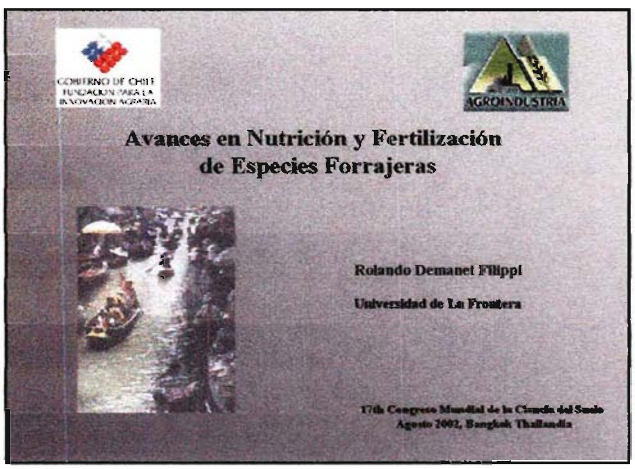
15^{00}-15^{30}	**Inscripción**
15^{30}-16^{15}	**Dra María de la Luz Mora** Una visión moderna del concepto de fertilidad de suelos y uso de fertilizantes
16^{15}-17^{00}	**Dr. Fernando Borie** Potencialidades de los Biofertilizantes
17^{00}-17^{30}	**Café**
17^{30}-18^{15}	**Ing. Agr. Rolando Demanet.** Avances en Nutrición Vegetal y Fertilización de Especies Forrajeras.


17th Congreso Mundial de la Ciencia del Suelo
Agosto 2002, Bangkok Thailandia
Enfrentando la Nueva Realidad del siglo 21


Thailandia
Bangkok


17th Congreso Mundial de la Ciencia del Suelo
4.368 Participantes
98 Paises


Quenn Sirikit National Convention Center
Bangkok, Thailandia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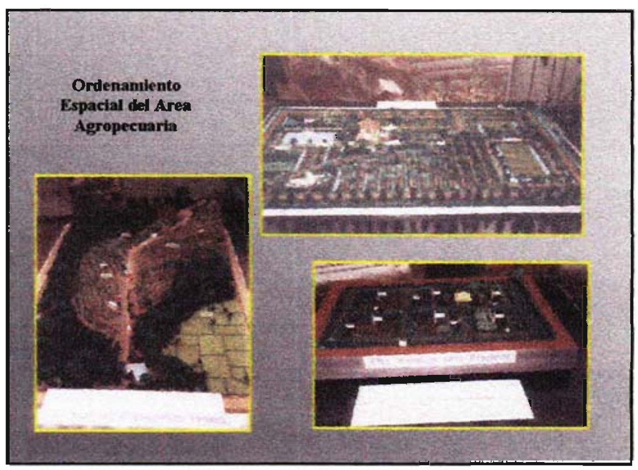
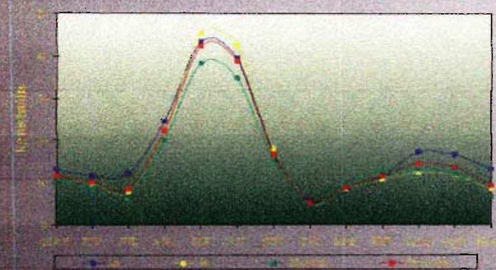
AGROINDUSTRIA
Avances en Nutrición y Fertilización
de Especies Forrajeras
Rolando Demanet Filippi
Universidad de La Frontera


Ordenamiento
Espacial del Area
Agropecuaria

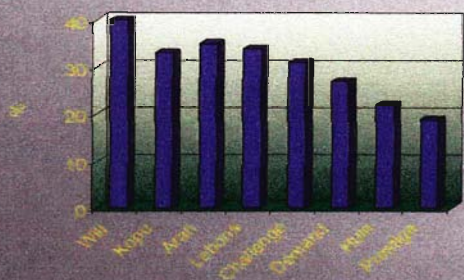
Ballicas

Ballica perenne

Curva de Crecimiento promedio de cultivares de ballicas diploides, teraploides y sus mezclas. Estación Experimental Las Encinas, Temuco. (Demanet, 2002)



Aporte porcentual de trébol blanco a la producción de materia seca de una pastura de Ballica perenne + Trébol blanco. Estación Experimental Maipo, Universidad de La Frontera. Temporada 95/99. (Demanet, 2000)



Materia seca efectivamente utilizada (ton ms/ha) según la eficiencia de utilización lograda en el predio.

Tipo de pastura	ton ms/ha	Eficiencia de utilización				
		40	50	60	70	75
Pradera Naturalizada	12	4,8	6,0	7,2	8,4	9,0
Ballica perenne + Trébol Blanco	14	5,6	7,0	8,4	9,8	10,5
Pasto ovillo + Festuca + Ballica + Trébol blanco	14	5,6	7,0	8,4	9,8	10,5

Efecto del porcentaje de utilización en el costo del kilo de materia seca efectivamente consumido por el animal. Octubre, 2002.

Tipo de pastura	$/ha	Eficiencia de utilización				
		40	50	60	70	75
Pradera Naturalizada	180.000	37,5	30,0	25,0	21,4	20,0
Ballica perenne + Trébol Blanco	230.000	41,1	32,9	27,4	23,5	21,9
Pasto ovillo + Festuca + Ballica + Trébol blanco	214.000	38,2	30,6	25,5	21,8	20,4

Rendimiento de cultivares de ballicas bianuales diploides. Estación Experimental Las Encinas. Temuco. 1998 –2000.

Cultivar	Ploidía	1998/99	1999/00	Promedio	Ranking
Flanker	2n	11.93	8.75	**10.34**	118
Fortyl	2n	9.81	7.96	**8.89**	101
Atlantis	2n	10.88	6.89	**8.88**	101
Fastyl	2n	9.50	8.19	**8.85**	101
Concord	2n	11.05	6.49	**8.77**	100
Siltem	2n	10.41	6.2	**8.31**	95
Conker	2n	8.46	5.77	7.12	81
Promedio		**10.29**	**7.18**	**8.74**	

Fuente: Demanet, 2001

Rendimiento de cultivares de ballicas bianuales tetraploides (4n). Estación Experimental Las Encinas. Temuco. 1998 –2000.

Cultivar	Ploidía	1998/99	1999/00	Promedio	Ranking
Domino	4n	10,70	9,12	**9,90**	114
Zorro	4n	10,20	9,39	**9,78**	112
Moutblanc	4n	**10,37**	8,51	**9,44**	108
Tonyl	4n	10,37	8,40	**9,39**	108
Sabalan	4n	10,64	8,05	**9,35**	107
Jeanne	4n	10,29	8,34	**9,32**	107
Ajax	4n	10,08	7,88	**8,98**	103
Idyl	4n	9,88	7,73	**8,81**	101
Tetrone	4n	9,53	7,91	**8,72**	100
Promedio		**10,23**	**8,37**	**9,30**	

Fuente: Demanet, 2001

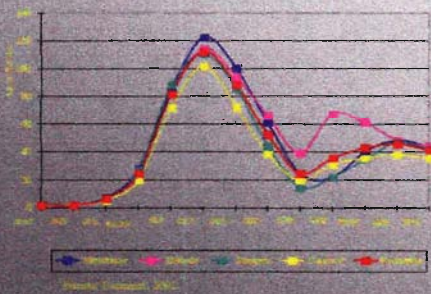
Rendimiento de cultivares de Ballicas Bianuales.

Estación Experimental Las Encinas. Temuco. 2001-2002.

Cultivar	Jul	Ago	Sep	Oct	Nov	Dic	Ene	Feb	Mar	Abr	May	Total	%
Belinda	0.21	0.65	1.57	3.11	3.74	2.52	1.52	1.30	1.70	1.16	1.85	**19.33**	**100**
Montblanc	0.18	0.80	1.60	3.27	4.14	2.39	0.96	0.32	0.80	1.18	1.84	**17.48**	**90**
Domino	*0.17*	*0.67*	*1.87*	*2.98*	*3.66*	*1.75*	*0.58*	*0.41*	*0.58*	*1.16*	*1.75*	**15.53**	**81**
Concord	0.18	0.53	1.31	2.93	3.09	1.49	0.78	0.58	0.84	0.85	1.50	**14.08**	73
Promedio	**0.19**	**0.66**	**1.59**	**3.07**	**3.66**	**2.04**	**0.96**	**0.65**	**0.98**	**1.09**	**1.74**	**16.62**	

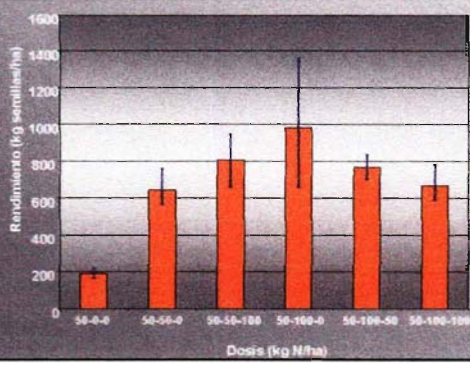
Fuente: Demanet, 2002

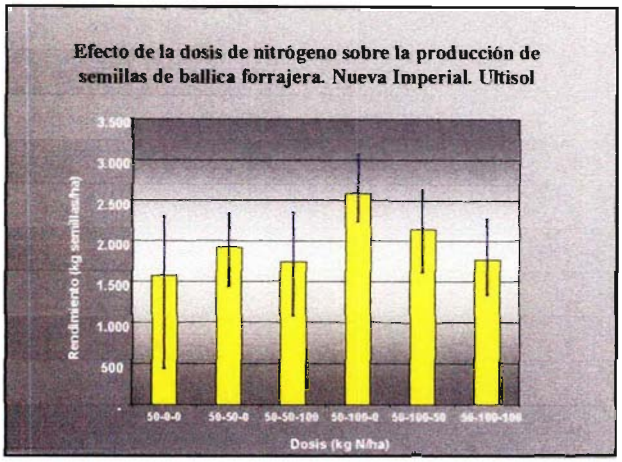
Tasa de crecimiento (ton ms/ha/día) de cultivares de ballicas bianuales. Estación Experimental Las Encinas. Universidad de la Frontera. Temuco, Temporada 2001 – 2002.

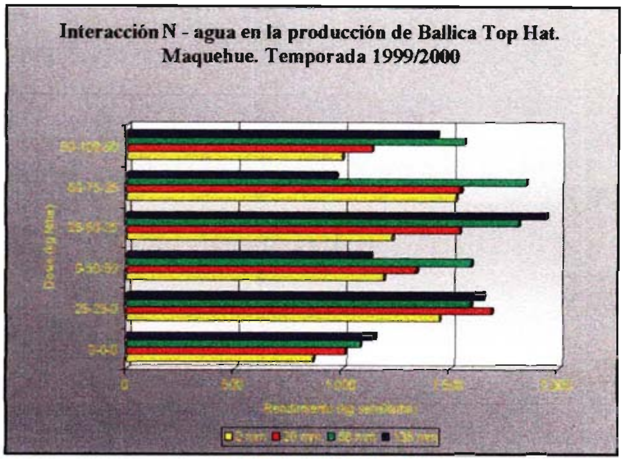


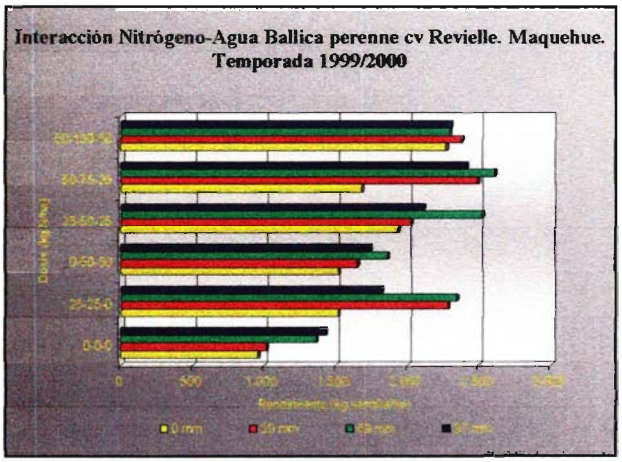
Fertilización en Producción de Semilla

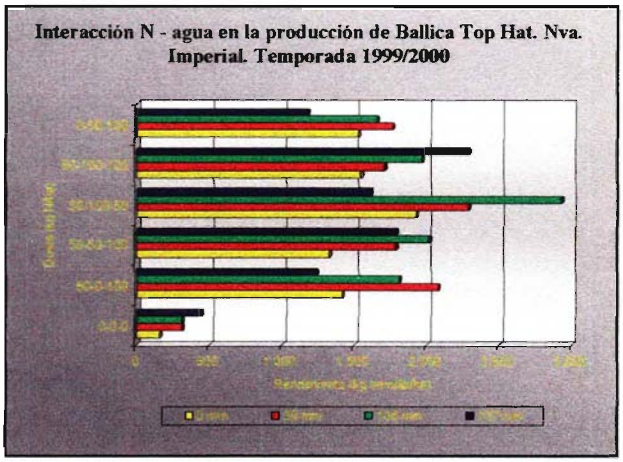
Efecto de la dosis de nitrógeno sobre la producción de semillas de ballica césped. Nueva Imperial. Ultisol

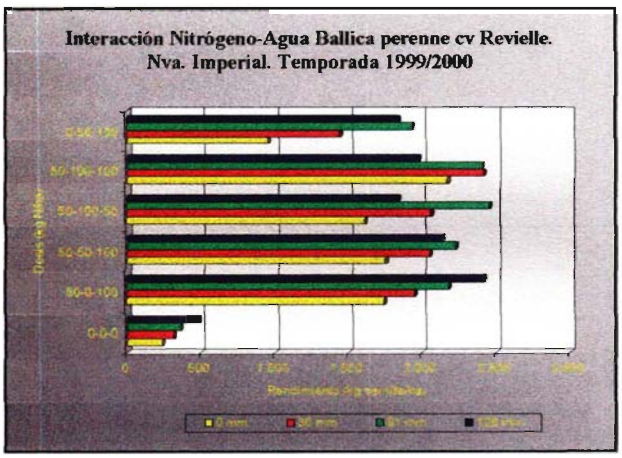


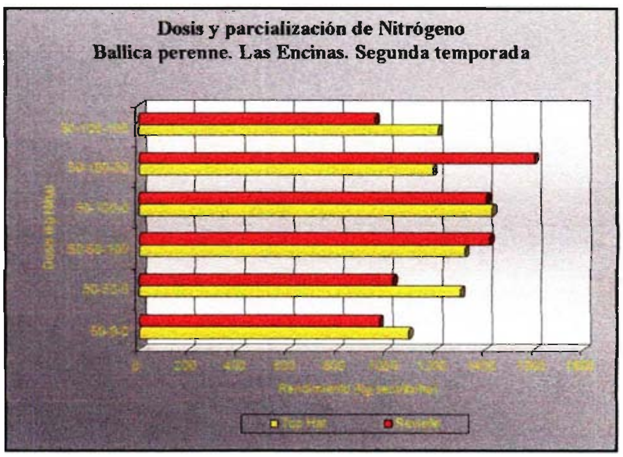

Efecto de la dosis de nitrógeno sobre la producción de semillas de ballica forrajera. Nueva Imperial. Ultisol
Rendimiento (kg semillas/ha)
3.500
3.000
2.500
2.000
1.500
1.000
500
50-0-0
50-50-0
50-50-100
50-100-0
50-100-50
50-100-100
Dosis (kg N/ha)

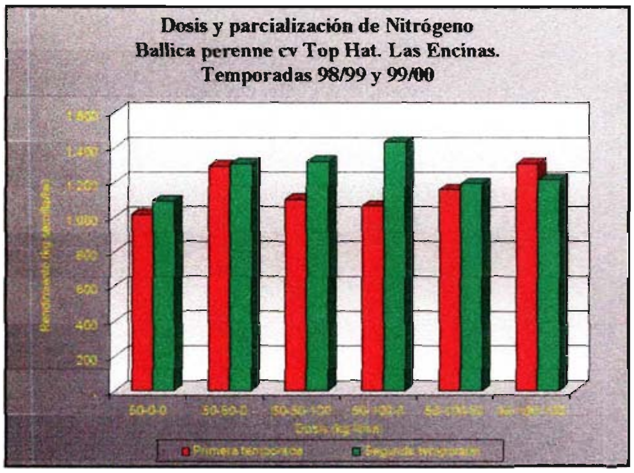

Interacción N - agua en la producción de Ballica Top Hat. Maquehue. Temporada 1999/2000

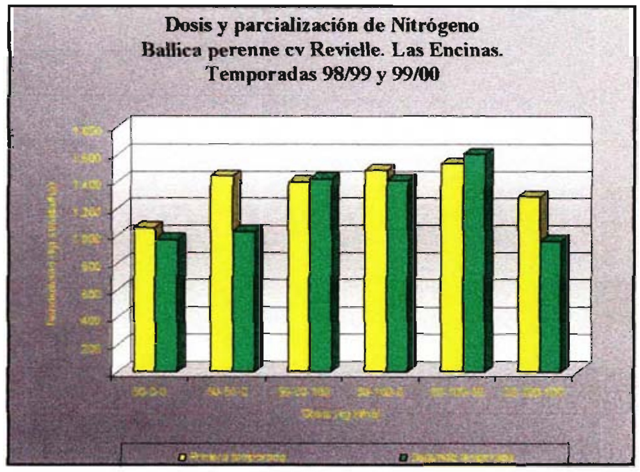

Interacción Nitrógeno-Agua Ballica perenne cv Revielle. Maquehue. Temporada 1999/2000

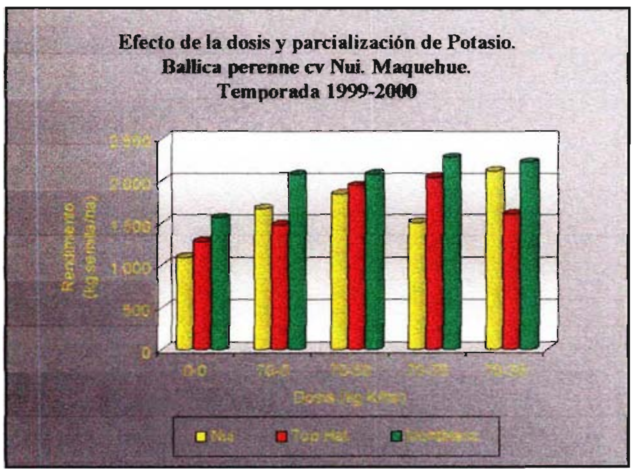

Interacción N - agua en la producción de Ballica Top Hat. Nva. Imperial. Temporada 1999/2000

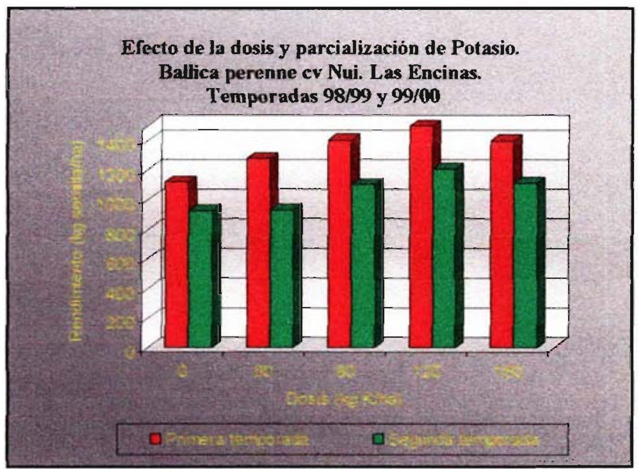

Interacción Nitrógeno-Agua Ballica perenne cv Revielle. Nva. Imperial. Temporada 1999/2000

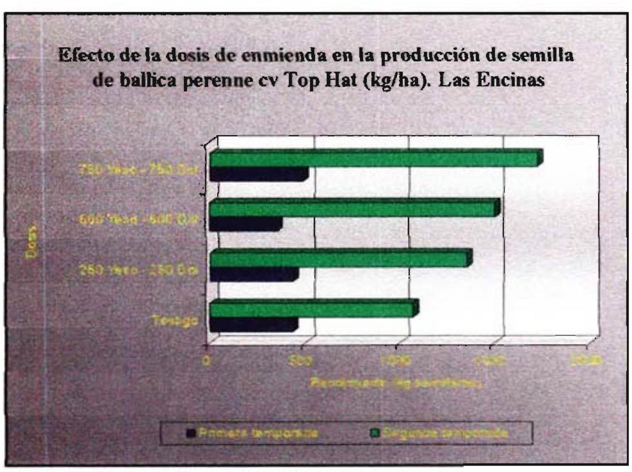

Dosis y parcialización de Nitrógeno
Ballica perenne. Las Encinas. Segunda temporada

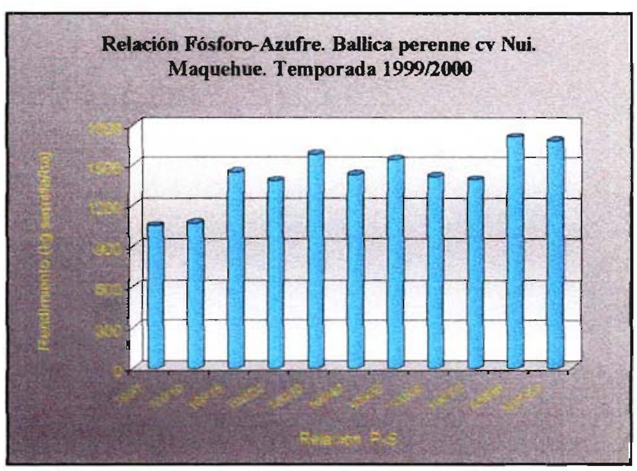

Dosis y parcialización de Nitrógeno
Ballica perenne cv Top Hat. Las Encinas.
Temporadas 98/99 y 99/00

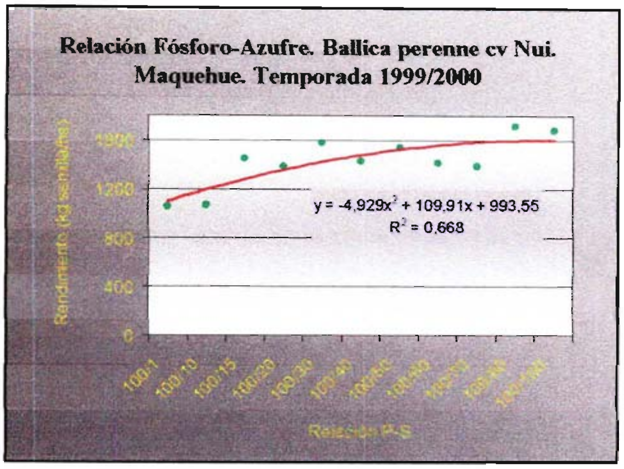

Dosis y parcialización de Nitrógeno
Ballica perenne cv Revielle. Las Encinas.
Temporadas 98/99 y 99/00

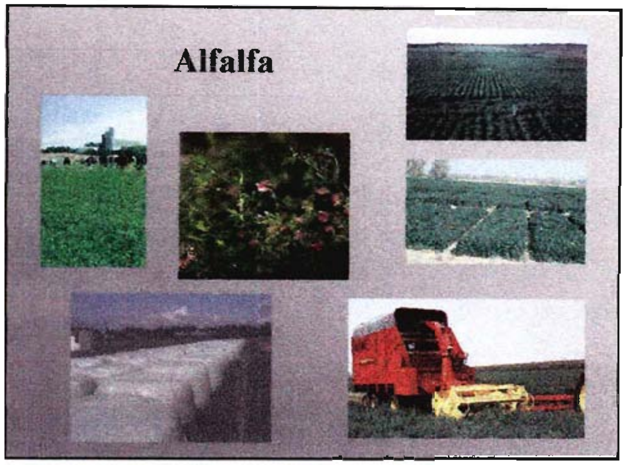

Efecto de la dosis y parcialización de Potasio.
Ballica perenne cv Nui. Maquehue.
Temporada 1999-2000

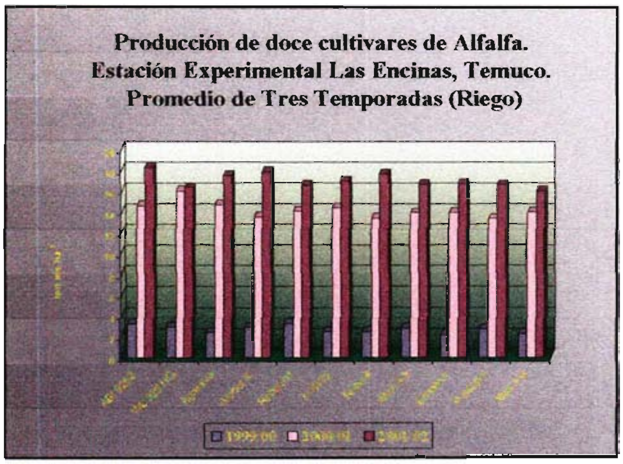

Efecto de la dosis y parcialización de Potasio.
Ballica perenne cv Nui. Las Encinas.
Temporadas 98/99 y 99/00

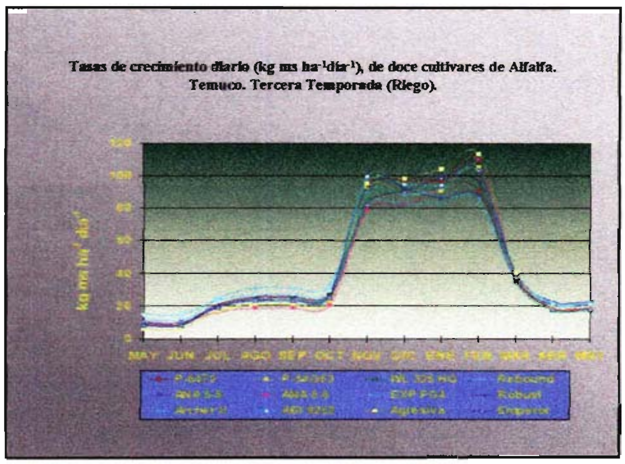

Efecto de la dosis de enmienda en la producción de semilla
de ballica perenne cv Top Hat (kg/ha). Las Encinas

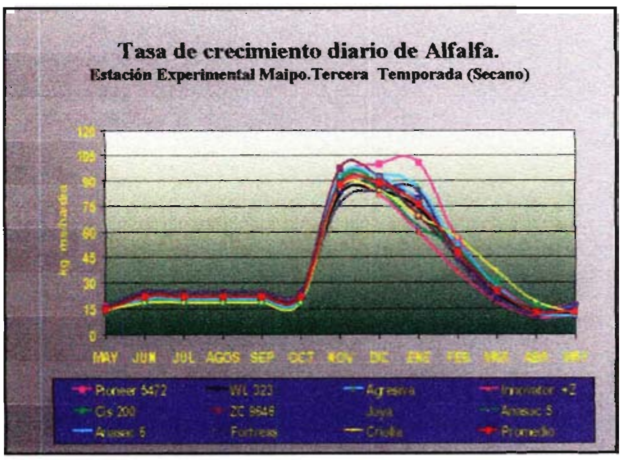

Relación Fósforo-Azufre. Ballica perenne cv Nui.
Maquehue. Temporada 1999/2000

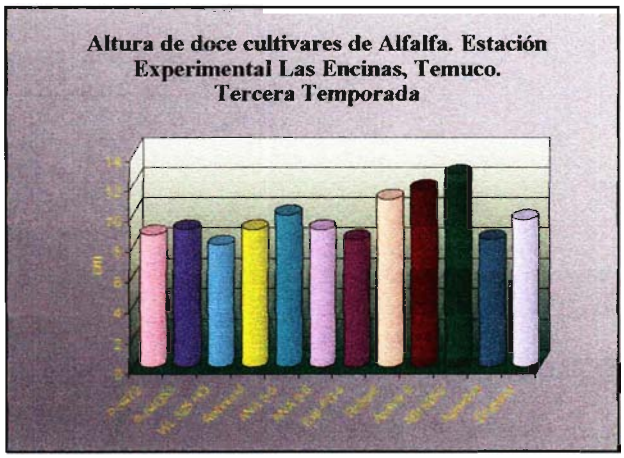

Relación Fósforo-Azufre. Ballica perenne cv Nui.
Maquehue. Temporada 1999/2000
y = -4,929x² + 109,91x + 993,55
R² = 0,668
1600
1200
800
400
0

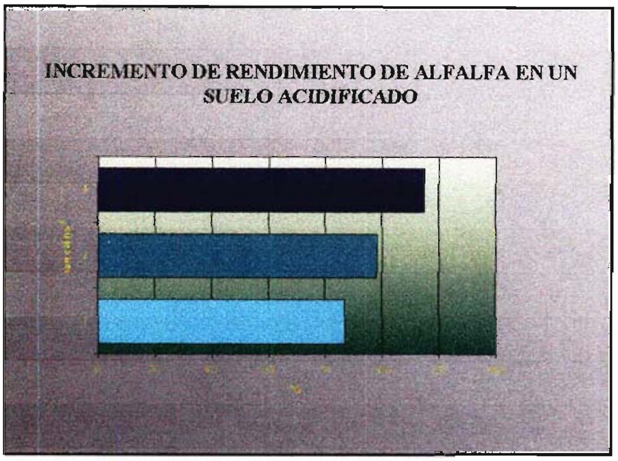

Alfalfa

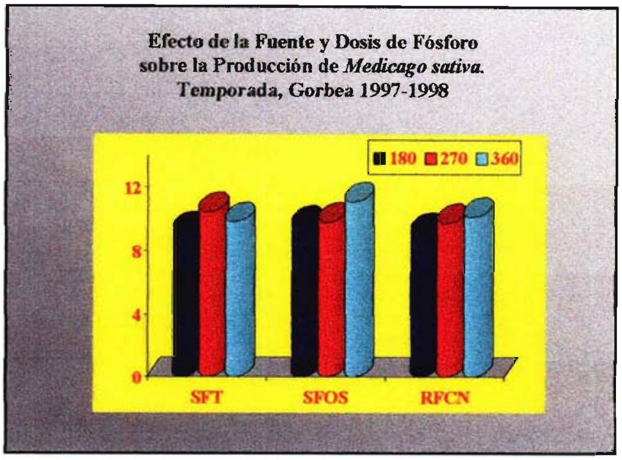

Producción de doce cultivares de Alfalfa.
Estación Experimental Las Encinas, Temuco.
Promedio de Tres Temporadas (Riego)

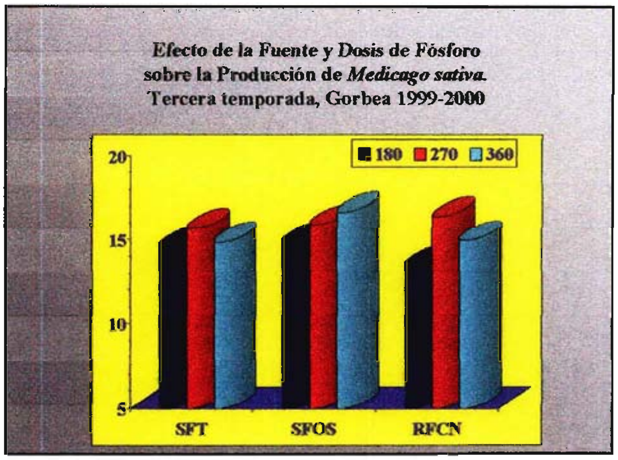

Tasas de crecimiento diario (kg ms ha-1día-1), de doce cultivares de Alfalfa.
Temuco. Tercera Temporada (Riego).

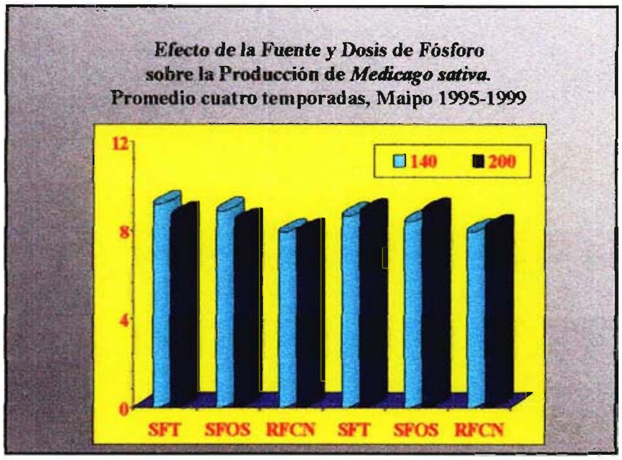

Tasa de crecimiento diario de Alfalfa.
Estación Experimental Maipo.Tercera Temporada (Secano)
MAY
JUN
JUL
AGOS
SEP
OCT
NOV
DIC
ENE
FEB

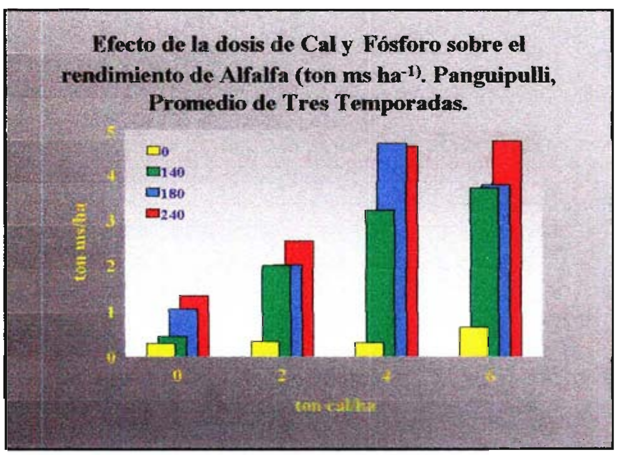

Altura de doce cultivares de Alfalfa. Estación
Experimental Las Encinas, Temuco.
Tercera Temporada

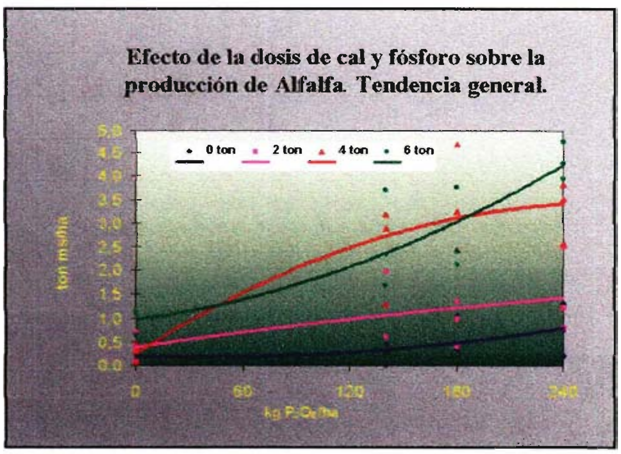

INCREMENTO DE RENDIMIENTO DE ALFALFA EN UN SUELO ACIDIFICADO


Efecto de la Fuente y Dosis de Fósforo
sobre la Producción de *Medicago sativa*.
Temporada, Gorbea 1997-1998
180
270
360
12
8
4
0
SFT
SFOS
RFCN

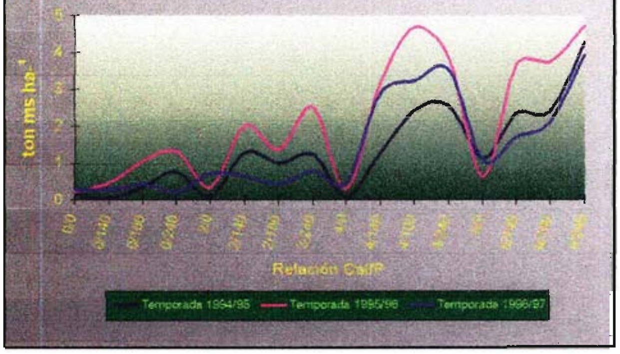

Efecto de la Fuente y Dosis de Fósforo
sobre la Producción de *Medicago sativa*.
Tercera temporada, Gorbea 1999-2000
180
270
360
20
15
10
5
SFT
SFOS
RFCN


Efecto de la Fuente y Dosis de Fósforo
sobre la Producción de *Medicago sativa*.
Promedio cuatro temporadas, Maipo 1995-1999
140
200
12
8
4
0
SFT
SFOS
RFCN
SFT
SFOS
RFCN


Efecto de la dosis de Cal y Fósforo sobre el
rendimiento de Alfalfa (ton ms ha^{-1}). Panguipulli,
Promedio de Tres Temporadas.
0
140
180
240
ton ms/ha
ton cal/ha
0
2
4
6


Efecto de la dosis de cal y fósforo sobre la
producción de Alfalfa. Tendencia general.
0 ton
2 ton
4 ton
6 ton
ton ms/ha
0
60
120
180
240

Efecto de la dosis de cal y fósforo sobre la producción de Alfalfa.

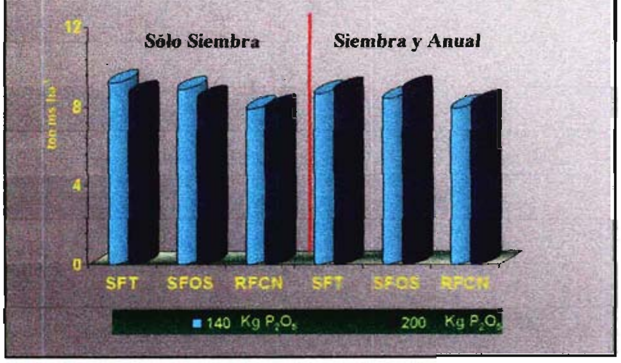


Efecto de la Fuente de Fósforo y Epoca de aplicación de P en Alfalfa. Estación Experimental Maipo, Temuco.

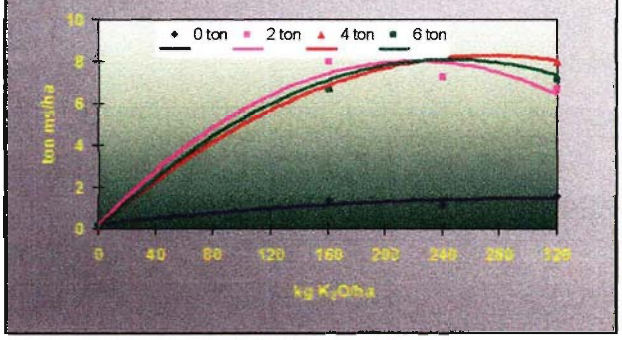
	SFT Sólo siembra	SFT 1° y 2° año	SuperFos sólo siembra	SuperFos 1° y 2° año
1996/97	12,51	12,96	12,70	12,81
1997/98	10,70	10,12	10,65	12,88
Promedio	11,61	11,54	11,68	11,84

Fósforo inicial: 19 ppm
Testigo sin P: 6,5 ton ms/ha

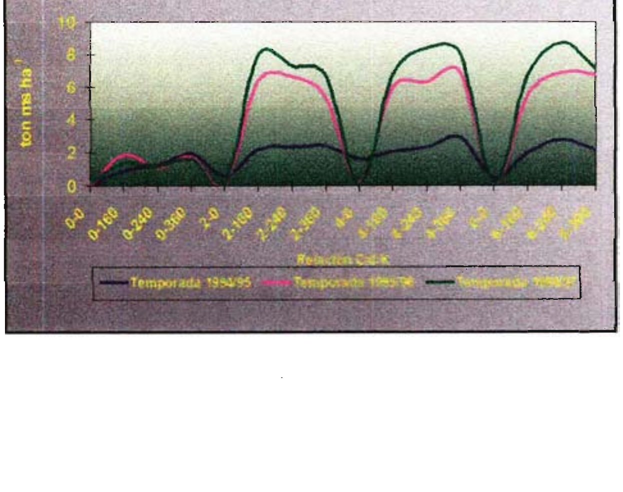
Efecto de la Fuente Tiempo de aplicación y Dosis de Fósforo sobre la Producción de Alfalfa. Promedio cuatro temporadas, Estación Experimental Maipo



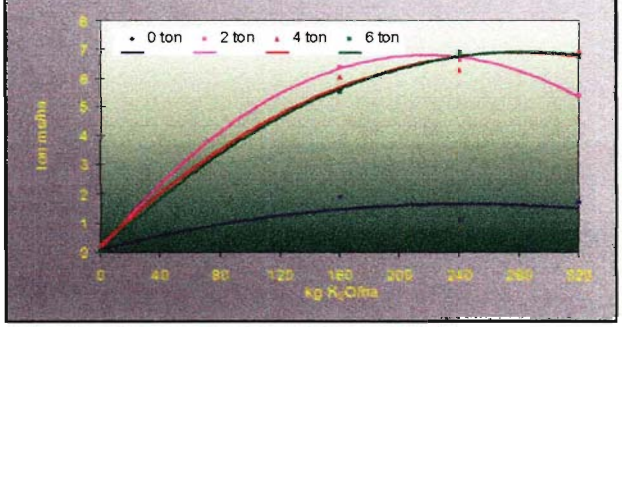
Efecto de la dosis de cal y potasio sobre de producción de Alfalfa. Primera Temporada



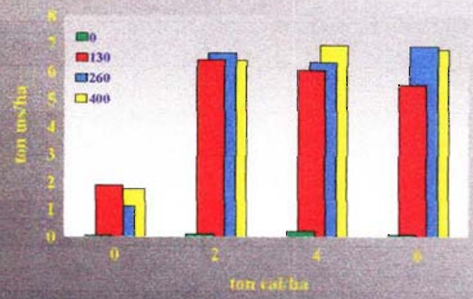
Efecto de la dosis de cal y Potasio sobre la producción de Alfalfa.



Efecto de la dosis de cal y potasio sobre de producción de Alfalfa. Promedio Tres Temporadas



EFECTO DE LA DOSIS DE CAL Y POTASIO SOBRE EL RENDIMIENTO DE ALFALFA.



Deficiencias Potasio

Trébol rosado

Rendimiento promedio de tres temporadas de cultivares de Trébol rosado. Estación Experimental Maipo. Universidad de La Frontera, Temuco. 1995 – 1998.

Cultivar	ton ms/ha	%
Toltén	7,13	117
Cautín	6,78	111
Redqueli	6,56	107
Quiñequeli	6,12	100
Sureño	5,50	90
Concorde	5,36	88
Estanzuela	5,35	87
Colenso	4,99	82
Violeta	4,57	75
Pawera	4,06	66
Promedio	**5,64**	

Fuente: Demanet y Cantero, 1999.

Trébol rosado + Ballica Bianual

Rendimiento de la asociación ballica bianual + trébol rosado (ton ms/ha). Estación Experimental Las Encinas. Instituto de Agroindustria, Universidad de La Frontera, Temuco.

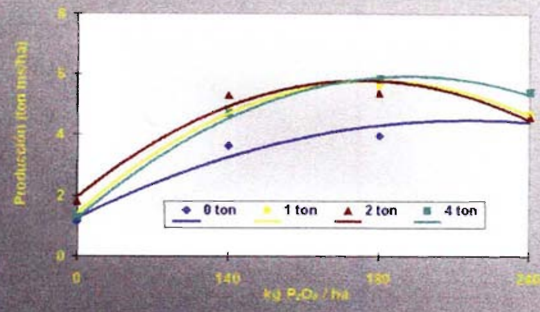
Cultivar	FECHAS DE CORTE						Total	%
	27/11/01	03/01/02	12/02/02	19/03/02	26/04/02	28/05/02		
Flanker	1,30	4,18	4,18	2,55	2,29	1,10	**15,59**	104
Concord	1,27	3,41	4,80	2,40	2,24	0,91	**15,02**	100
Marbella sud	1,09	3,73	3,74	2,66	2,49	0,92	**14,62**	97
Crusader	1,36	3,72	3,20	2,70	2,46	0,92	**14,37**	96
Montblanc	0,86	4,28	4,17	2,12	2,43	0,93	**14,80**	100
Domino	1,08	3,80	3,75	2,24	2,95	1,01	**14,83**	100
Promedio	**1,16**	**3,85**	**3,97**	**2,45**	**2,48**	**0,97**	**14,87**	

Aporte porcentual de trébol rosado a la composición botánica de la asociación Ballica bianual + Trébol rosado. Estación Experimental Las Encinas. Universidad de La Frontera.

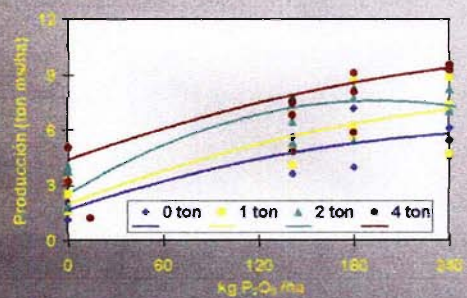
Cultivar	FECHAS DE CORTE						Total	Promedio
	27/11/01	03/01/02	12/02/02	19/03/02	26/04/02	28/05/02		
Flanker	1	4	10	15	10	4	8	
Concord	0	11	12	17	10	20	12	
Marbella sud	2	4	13	20	14	11	11	
Crusader	0	8	16	5	22	10	11	10
Montblanc	0	12	36	37	21	11	23	
Domino	0	8	31	40	22	7	21	22
Promedio	**0**	**8**	**20**	**22**	**17**	**10**	**14**	

Fuente: Demanet y Contreras, 1999

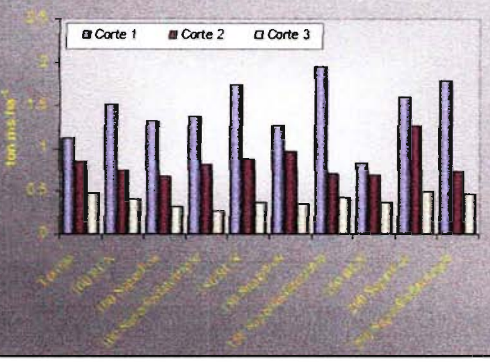
Efecto de la dosis de Cal y P sobre la producción de *Trifolium pratense*. Primera temporada (94/95)



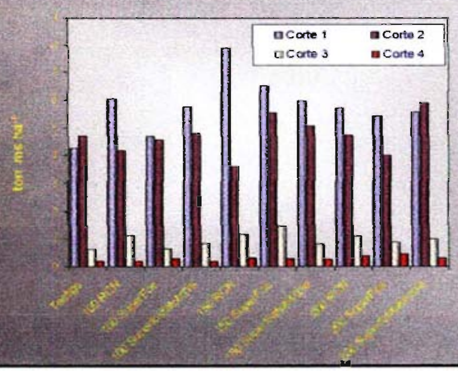
Tendencia general de la producción de *Trifolium pratense* establecido baja diferente relaciones de Ca/P en un andisol acidificado. periodo 1994-1997.



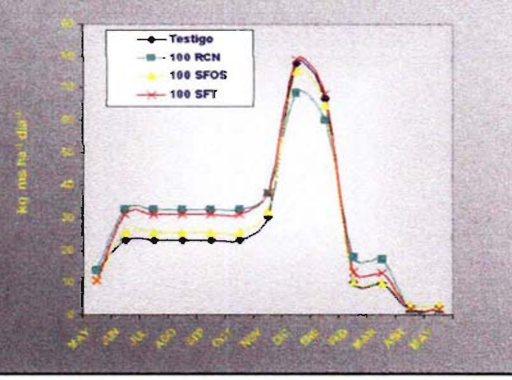
Producción por corte (ton ms/ha), de 10 tratamientos de P_2O_5 en *Trifolium pratense*. Gorbea. Primera Temporada 1997/98.



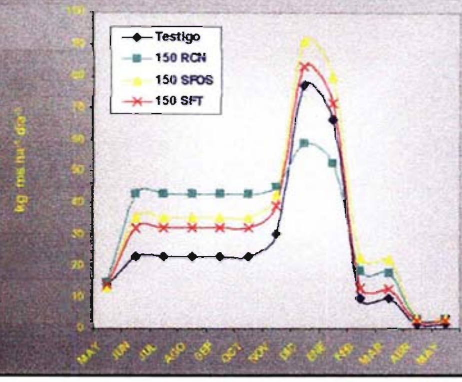
Producción especie pura por corte (ton ms/ha), de 10 tratamientos de P_2O_5 en *Trifolium pratense*. Gorbea. Segunda Temporada 1998/99.



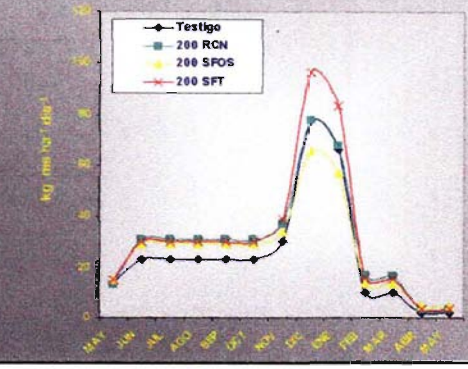
Tasas de crecimiento diario (kg ms/ha/día), de 10 tratamientos de P_2O_5 en *Trifolium pratense*. Gorbea, Segunda Temporada 1998/99.



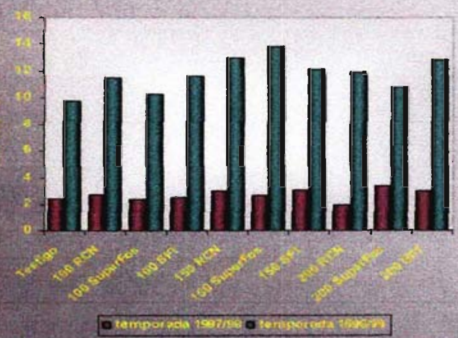
Tasas de crecimiento diario (kg ms/ha/día), de 10 tratamientos de P_2O_5 en *Trifolium pratense*. Gorbea, Segunda Temporada 1998/99.



Tasas de crecimiento diario (kg ms/ha/día), de 10 tratamientos de P_2O_5 en *Trifolium pratense*. Gorbea, Segunda Temporada 1998/99.



Producción Trébol rosado (ton ms/ha) por temporada y promedio de 10 tratamientos de P_2O_5 en *Trifolium pratense*. Gorbea.



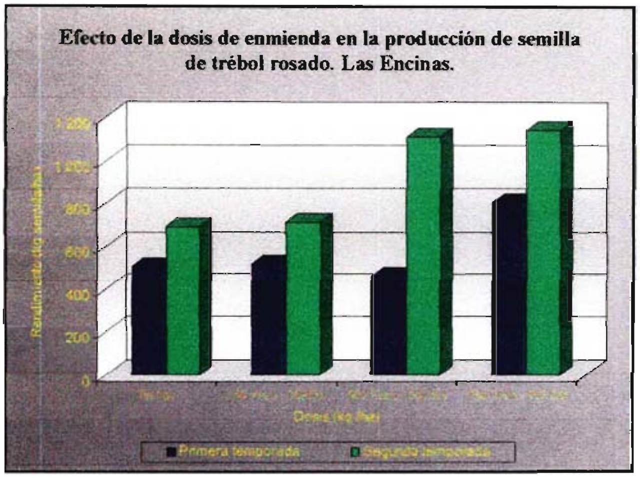
Eficiencia agronómica relativa de la producción de forraje en la temporada 1998-99, de los tratamientos de P_2O_5 en *Trifolium pratense*.

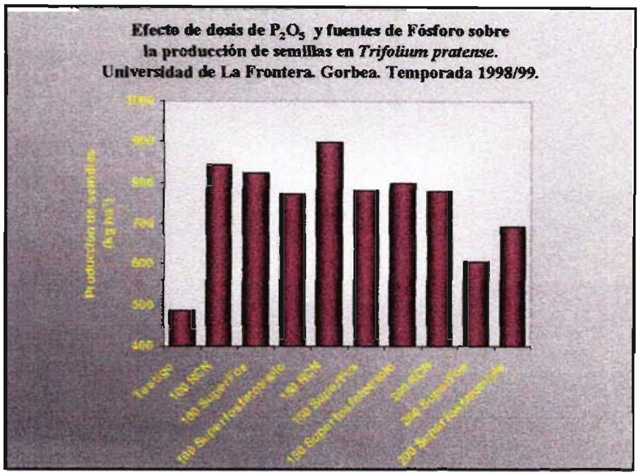
	EAR (%)
100 RCN	95,53
100 SUPERFOS	25,14
150 RCN	79,55
150 SUPERFOS	172,85
200 RCN	69,87
200 SUPERFOS	32,45

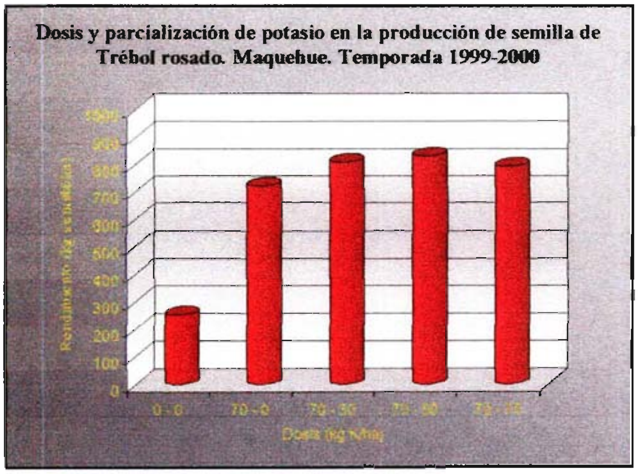
Eficiencia Agronómica Relativa de la producción de semilla en la temporada 1998-99, de los tratamientos de P_2O_5 en *Trifolium pratense*.

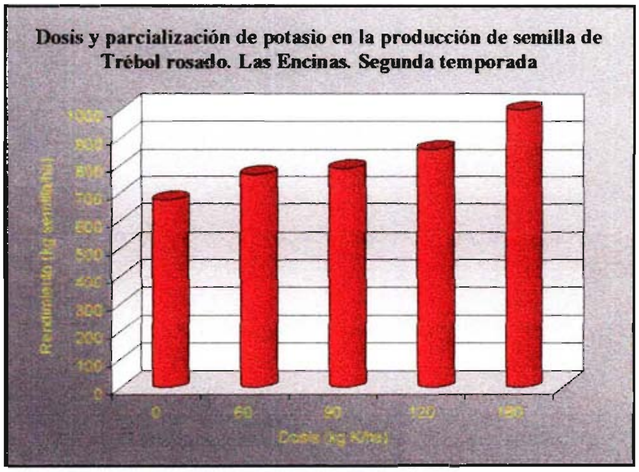
	EAR (%)
100 RCN	123,61
100 SUPERFOS	117,01
150 RCN	132,80
150 SUPERFOS	94,53
200 RCN	140,58
200 SUPERFOS	58,45

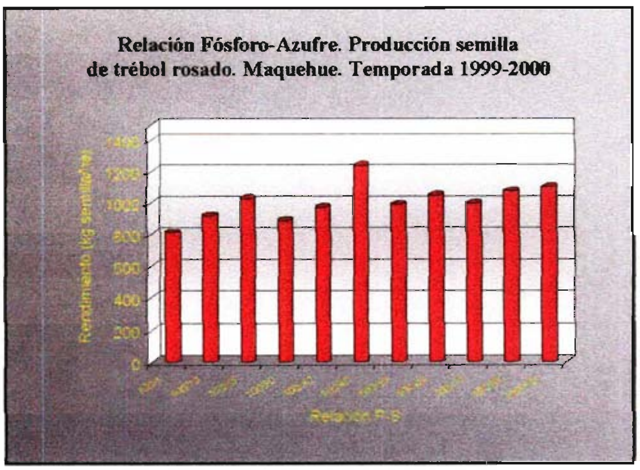
Producción de semilla Trébol rosado

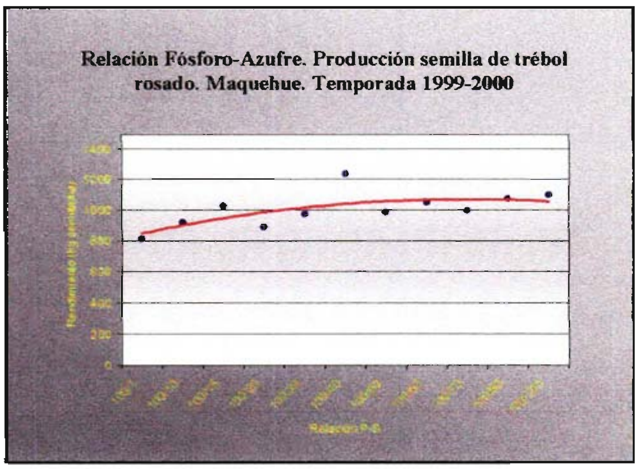

Efecto de la dosis de enmienda en la producción de semilla de trébol rosado. Las Encinas.
Dosis (kg/ha)
Primera temporada
Segunda temporada


Efecto de dosis de P_2O_5 y fuentes de Fósforo sobre la producción de semillas en *Trifolium pratense*. Universidad de La Frontera. Gorbea. Temporada 1998/99.
Testigo

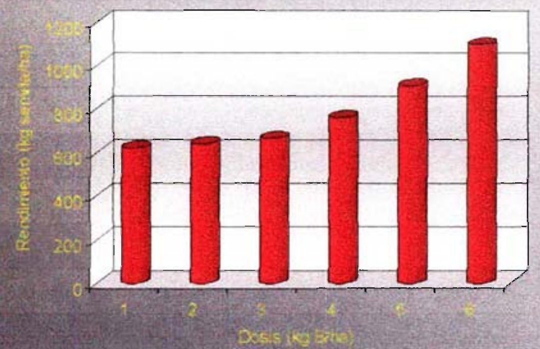

Dosis y parcialización de potasio en la producción de semilla de Trébol rosado. Maquehue. Temporada 1999-2000
0 - 0
70 - 0
Dosis (kg K/ha)


Dosis y parcialización de potasio en la producción de semilla de Trébol rosado. Las Encinas. Segunda temporada
0
60
90
120
180
Dosis (kg K/ha)

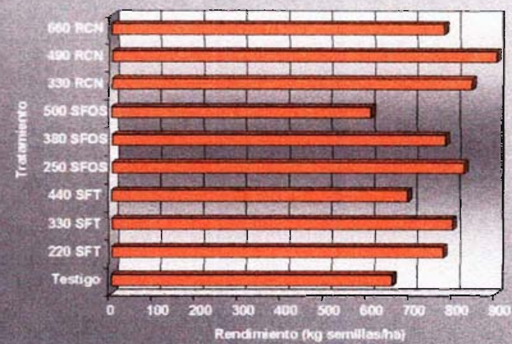

Relación Fósforo-Azufre. Producción semilla de trébol rosado. Maquehue. Temporada 1999-2000
Relación P-S


Relación Fósforo-Azufre. Producción semilla de trébol rosado. Maquehue. Temporada 1999-2000

Efecto de la dosis de boro en la producción de semilla de trébol rosado. Maquehue. Temporada 1999/2000



Efecto de la fuente de fósforo sobre la producción de trébol rosado



Relación Concentración Planta/Suelo

- Suelo
- Ambiente

Relación entre la concentración de nutrientes en la planta y el suelo en praderas templadas

Elemento (%)	Suelo	Planta	Planta/Suelo
N	0,28	2,80	10,00
P	0,20	0,40	2,00
S	0,10	0,35	3,50
K	1,50	2,50	1,70
Na	0,25	0,25	1,00
Ca	1,80	0,60	0,33
Mg	0,80	0,20	0,25

Whitehead, 2000

Relación entre la concentración de nutrientes en la planta y el suelo en praderas templadas

Elemento (ppm)	Suelo	Planta	Planta/Suelo
Mn	1.600	165	0,10
Zn	150	37	0,25
Cu	30	9	0,30
B	50	5	0,10
Mo	2,6	0,90	0,35
Se	0,4	0,05	0,12

Whitehead, 2000

Concentración de Nutrientes en las Plantas

- Ambiente
- Suelo
- Especie
- Cultivar
- Fertilización

Concentración de Nutrientes en el Follaje de Especies Gramíneas Forrajeras (bms)

Elemento (%)	Ballica perenne	Pasto ovillo	Timothy	Festuca
N	2,10	2,80	2,50	2,60
P	0,32	0,32	0,13	0,30
K	2,30	2,60	1,70	2,10
Ca	0,87	0,57	0,88	0,87
Mg	0,17	0,15	0,27	0,18

Elemento (ppm)	Ballica perenne	Pasto ovillo	Timothy	Festuca
Mn	41	105	38	29
Zn	20	23	19	16
Cu	5,0	7,1	4,6	4,9
B	9	10	17	10
Mo	0,47	0,77	0,58	0,60

Concentración de Nutrientes en el Follaje de Especies Leguminosas Forrajeras (bms)

Elemento (%)	Trébol blanco	Trébol rosado	Alfalfa
N	4,42	3,40	2,94
P	0,38	0,27	0,26
S	0,29	0,21	0,27
K	2,26	2,07	1,65
Ca	2,10	1,84	1,82
Mg	0,18	0,21	0,15

Elemento (ppm)	Trébol blanco	Trébol rosado	Alfalfa
Mn	49	44	42
Zn	25	24	24
Cu	7,3	7,4	7,0
B	31	27	38
Mo	0,64	0,44	0,18

Concentración de Nutrientes en el Follaje de Especies Forrajeras (bms)

Elemento (%)	Ballica perenne	Achicoria	Plantago
N	2,07	2,30	2,00
P	0,29	0,42	0,35
K	2,50	5,10	2,30
Ca	0,40	1,60	2,60
Mg	0,14	0,27	0,19

Relación entre el contenido de Nutrientes en la Planta y el Animal

Elemento (%)	Input		Reserva Animal		Output	
	Consumo Diario g/día	Absorción g/día	Total g	Disponible g	Fecas y Orina g/día	Leche g/día
Ca	100	34	6.000	3	8	26
Mg	20	4	175	0,75	1,5	2,5
K	50	50	820	185	22,5	28
Na	20	20	700	35	6,5	13

Relación entre la concentración de nutrientes de rumiantes y el contenido una pastura templada

Elemento (%)	Planta	Animal	Animal/Planta
N	2,80	9,00	3,20
P	0,40	2,66	6,70
S	0,35	0,50	1,40
K	2,50	0,67	0,27
Na	0,25	0,50	2,00
Ca	0,60	4,66	7,80
Mg	0,20	0,15	0,75

Elemento (ppm)	Planta	Animal	Animal/Planta
Mn	165	1,2	0,007
Zn	37	83	2,2
Cu	9	9	1
B	5	1	0,2
Mo	0,90	0,66	0,83
Se	0,05	1,2	24

Distribución de Macronutrientes en la secreción de leche, Fecas y Orina de vacas lecheras que consumen una pastura de tipo templada

Nutriente	Concentración Follaje %	Consumo g/día	Secreción 25 kg Leche g/día	Fecas g/día	Orina g/día
P	0,41	66	24	48	0,2
S	0,42	67	7	18	42
K	3,02	483	41	53	389
Na	0,37	59	10	9	40
Ca	0,61	98	30	68	0,5
Mg	0,23	37	3	31	3,0

Reciclaje de Nitrógeno en animales en pastoreo
Pastura Ballica + Trébol

Tipo Animal	Fertilización kg N/ha/año	% N Follaje bms	Bosta kg N/ha	Orina kg N/ha	Orina % N Excretado
Vacas	250	3,3	86	214	71
	540	4,1	104	354	77
Novillos	0	2,8	58	74	56
	210	3,1	62	93	60
	420	3,7	84	237	74

Efecto de la aplicación de S en la ganancia de peso de Corderos alimentados con dos tipos de praderas

	Fertilización S (kg/ha)		
Ballica	0	45	90
% N Follaje	1,66	2,03	2,04
% S Follaje	0.14	0.18	0.2
N:S	12.3	11.3	10,3
Consumo kg/día	1,57	1,65	1,71
Ganancia peso g/día	141	180	207
Ballica + Trébol			
% N Follaje	1,12	1,17	1,24
% S Follaje	0.09	0.17	0.21
N:S	12,4	7,1	6
Consumo kg/día	1,3	1,27	1,58
Ganancia peso g/día	32	88	113

Concentración de B en estado de floración

Especie	ppm Boro
Bromo	3
Timothy	3
Pasto ovillo	5
Trébol rosado	29
Alfalfa	26

Efecto del pH en la concentración de Mo En Ballica perenne y Trébol blanco

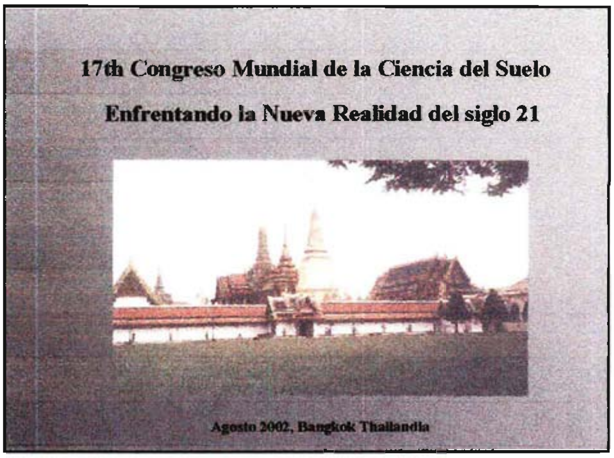
Especie	pH					
	5,0	5,5	6,0	6,5	7,0	7,5
Ballica	1,1	1,6	2,7	4	4,3	5,2
Trébol	0,9	1,3	2,7	3,9	5,7	5,9

Balance de B, Mo y Se (g/ha/año) en sistema intensivo de vacas lecheras en pastoreo, manejadas en pradera de Ballica + trébol

	B	Mo	Se
Inputs			
Fertilización	6	7	0,3
Atmósfera	150	2	3
Reciclaje			
Absorción Forraje	150	40	10
Consumo animal	120	32	8
Material muerto	60	16	4
Raices muertas	60	20	3
Excretas	96	26	6,5
Output			
Leche	7	0,7	0,2
Pérdida por lluvia	60	1	1
Pérdida por excretas	17	5	1,2
Ganancia/Pérdida en el suelo	82	2	0,6

Balance de Mn, Zn y Cu (g/ha/año) en sistema intensivo de vacas lecheras en pastoreo, manejadas en pradera de Ballica + trébol

	Mn	Zn	Cu
Inputs			
Fertilización	15	7	2
Atmósfera	100	700	210
Reciclaje			
Absorción Forraje	1000	600	150
Consumo animal	800	480	120
Material muerto	400	240	60
Raíces muertas	1000	200	125
Excretas	540	405	110
Output			
Leche	0,25	42	0,7
Pérdida por lluvia	2,5	2,3	0,7
Pérdida por excretas	95	70	20
Ganancia/Pérdida en el suelo	580	190	6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Conferencia a los Estudiantes de Postgrado y Tesistas de Agronomía

Como parte de las

Actividades de Difusión del Programa de Formación para la Innovación Agraria

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Programa

Jueves 21 de Noviembre

Trabajos Presentados por los proponentes en el 17 Congreso Internacional de las Ciencias del Suelo

09^{00}-10^{00} **Dr. Fernando Borie**
Influencia de los tipos de nitrógeno fertilizante en la nutrición mineral del trigo y micorrizas

10^{00}-11^{00} **Ing. Agr. Rolando Demanet.**
Efecto de la fertilización y manejo en la producción de trébol rosado en suelos volcánicos

11^{00}-12^{00} **Dra María de la Luz Mora**
Efecto de la Materia Orgánica y las Propiedades de Suelos Volcánicos sobre la adsorción de sulfatos

17th Congreso Mundial de la Ciencia del Suelo

Agosto 2002, Bangkok Thailandia

Enfrentando la Nueva Realidad del siglo 21

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Agosto 2002, Bangkok Thailandia

17th Congreso Mundial de la Ciencia del Suelo

Agosto 2002, Bangkok Thailandia

4.368 Participantes
98 Países

Quenn Sirikit National Convention Center
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Ordenamiento Espacial del Area Agropecuaria

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Efecto de la Fertilización con Boro en la Producción de Semilla de Trébol rosado en Suelos Volcánicos de Chile

Rolando Demanet Filippi
Maria de la Luz Mora Gil
Universidad de La Frontera

17th Congreso Mundial de la Ciencia del Suelo
Agosto 2002, Bangkok Thailandia

Trébol rosado




Producción de semilla de Trébol rosado en la IX Región

- Utilización: Pastoreo, Conservación de forraje y Producción de semilla
- Producción de semilla como subproducto producción de forraje
- Siembra asociada a cereales
- Cosecha segundo año
- 5.000 ha destinadas a la producción de semilla
- Rendimiento promedio 250 kg semilla/ha
- Mal manejo de Agronómico del cultivo
- Carencia de agentes polinizantes
- Problemas de Cúscuta y Orobanche
- Mercado Nacional y Exportación

Producción de Forraje

- Persitencia tres años
- Establecimiento solo o asociado
- Asociación con cereales
- Asociación con ballicas de rotación
- Asociación con ballica + cereal

Rendimiento promedio de tres temporadas de cultivares de Trébol rosado. Estación Experimental Maipo. Universidad de La Frontera, Temuco. 1995 – 1998.

Cultivar	ton ms/ha	%
Toltén	7,13	117
Cautín	6,78	111
Redqueli	6,56	107
Quiñequeli	6,12	100
Sureño	5,50	90
Concorde	5,36	88
Estanzuela	5,35	87
Colenso	4,99	82
Violeta	4,57	75
Pawera	4,06	66
Promedio	5,64	

Fuente: Demanet y Cantero, 1999

Trébol rosado + Ballica Bianual




Rendimiento de la asociación ballica bianual + trébol rosado (ton ms/ha). Estación Experimental Las Encinas. Instituto de Agroindustria, Universidad de La Frontera, Temuco.

Cultivar	FECHAS DE CORTE						Total	%
	27/11/01	03/01/02	12/02/02	19/03/02	26/04/02	28/05/02		
Flanker	1,30	4,18	4,18	2,55	2,29	1,10	15,59	104
Concord	1,27	3,41	4,80	2,40	2,24	0,91	15,02	100
Marbella sud	1,09	3,73	3,74	2,66	2,49	0,92	14,62	97
Crusader	1,36	3,72	3,20	2,70	2,46	0,92	14,37	96
Montblanc	0,86	4,28	4,17	2,12	2,43	0,93	14,80	100
Domino	1,08	3,80	3,75	2,24	2,95	1,01	14,83	100
Promedio	1,16	3,85	3,97	2,45	2,48	0,97	14,87	

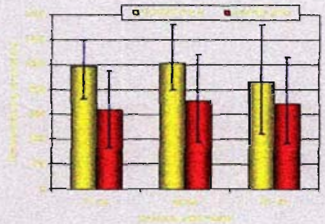
Fuente: Demanet y Cantero, 1999

Aporte porcentual de trébol rosado a la composición botánica de la asociación Ballica bianual + Trébol rosado. Estación Experimental Las Encinas. Universidad de La Frontera.

Cultivar	FECHAS DE CORTE						Total	Promedio
	27/11/01	03/01/02	12/02/02	19/03/02	26/04/02	28/05/02		
Flanker	1	4	10	15	10	4	**8**	
Concord	0	11	12	17	10	20	**12**	
Marbella sud	2	4	13	20	14	11	**11**	
Crusader	0	8	16	5	22	10	**11**	10
Montblanc	0	12	36	37	21	11	**23**	
Domino	0	8	31	40	22	7	**21**	22
Promedio	**0**	**8**	**20**	**22**	**17**	**10**	**14**	

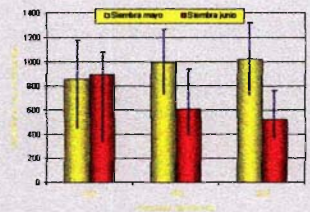
Fuente: Demanet y Cantero, 1999

Efecto de la Distancia enter Hilera en la producción de semilla de Trébol rosado

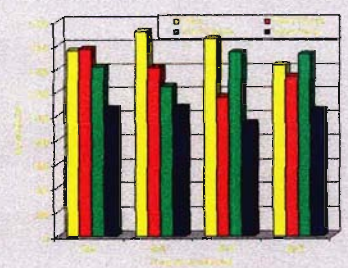


Producción de semilla de Trébol rosado

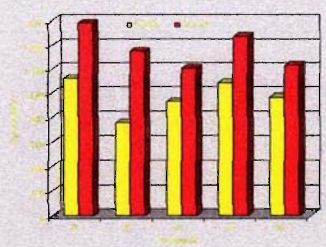
Efecto de la Densidad de Plantas en la producción de semilla de Trébol rosado



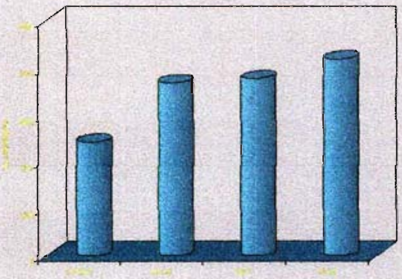
Asociación con Cereales, Dosis de semilla y Distancia entre Hilera en la producción de semilla de Trébol rosado



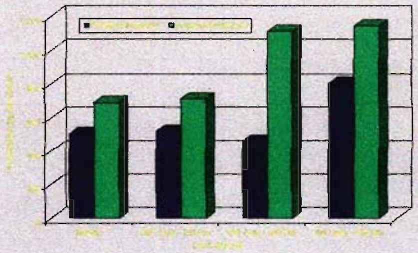
Inoculación y Peletización con Molibdeno en la producción de semilla de Trébol rosado



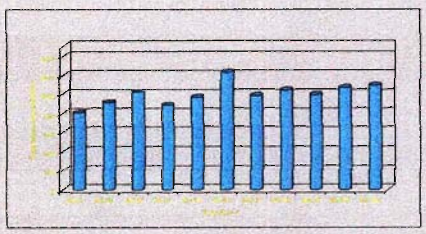
Efecto de la fuente de Fósforo en la producción de semilla de Trébol rosado



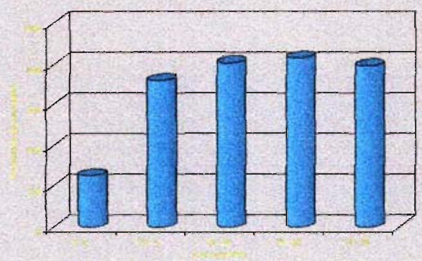
Efecto de la Aplicación de Enmienda en la producción de semilla de Trébol rosado



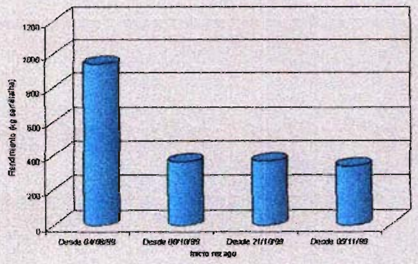
Relación Azufre Fósforo en la producción de semilla de Trébol rosado



Efecto de la dosis y Parcialización de Potasio en la producción de semilla de Trébol rosado



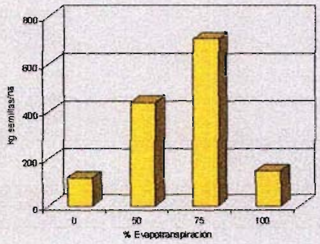
Efecto de la época de rezago en la producción de semilla de Trébol rosado



Efecto de la Aplicación de desecantes en la cosecha de semilla de Trébol rosado

Desecante	kg semillas/ha	%
Directa	531	100
Paraquat	632	119
Paraquat + Diquat	632	119
Promedio	**598**	**113**

Efecto de la diferentes cargas de agua de riego en la producción de semilla de Trébol rosado



Polinización de Trébol rosado con *Bombus ruderatus*

Especie	Fecha	Flores/Inflorescencia	Tiempo (seg)
Bombus ruderatus	6 de enero	5,8	17,6
	14 de enero	7	14,8
	21 de enero	6,3	9,9
	28 de enero	7,4	15,7

Polinización de Trébol rosado con *Bombus ruderatus*

Especie	Fecha	Flores/Inflorescencia	Tiempo (seg)
Bombus ruderatus	4 de febrero	6,6	15,9
	11 de Febrero	6,2	15,1
Bombus dahlbomi	4 de febrero	6,1	9,8
	11 de Febrero	5,5	10

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Relación entre la concentración de nutrientes en la planta y el suelo en praderas templadas

Elemento (ppm)	Suelo	Planta	Planta/Suelo
Mn	1.600	165	0,10
Zn	150	37	0,25
Cu	30	9	0,30
B	50	5	0,10
Mo	2,6	0,90	0,35
Se	0,4	0,05	0,12

Whitehead, 2000

Concentración de Nutrientes en las Plantas

- Ambiente
  Suelo
- Especie
- Cultivar
- Fertilización

Concentración de Nutrientes en el Follaje de Especies Gramíneas Forrajeras (bms)

Elemento (ppm)	Ballica perenne	Pasto ovillo	Timothy	Festuca
Mn	41	105	38	29
Zn	20	23	19	16
Cu	5,0	7,1	4,6	4,9
B	9	10	17	10
Mo	0,47	0,77	0,58	0,60

Concentración de Nutrientes en el Follaje de Especies Leguminosas Forrajeras (bms)

Elemento (%)	Trébol blanco	Trébol rosado	Alfalfa
N	4,42	3,40	2,94
P	0,38	0,27	0,26
S	0,29	0,21	0,27
K	2,26	2,07	1,65
Ca	2,10	1,84	1,82
Mg	0,18	0,21	0,15
Elemento (ppm)	**Trébol blanco**	**Trébol rosado**	**Alfalfa**
Mn	49	44	42
Zn	25	24	24
Cu	7,3	7,4	7,0
B	31	27	38
Mo	0,64	0,44	0,18

Relación entre la concentración de nutrientes de rumiantes y el contenido una pastura templada

Elemento (ppm)	Planta	Animal	Animal/Planta
Mn	165	1,2	0,007
Zn	37	83	2,2
Cu	9	9	1
B	5	1	0,2
Mo	0,90	0,66	0,83
Se	0,05	1,2	24

Concentración de B en estado de floración

Especie	ppm Boro
Bromo	3
Timothy	3
Pasto ovillo	5
Trébol rosado	29
Alfalfa	26

Efecto del pH en la concentración de Mo En Ballica perenne y Trébol blanco

Especie	pH					
	5,0	5,5	6,0	6,5	7,0	7,5
Ballica	1,1	1,6	2,7	4	4,3	5,2
Trébol	0,9	1,3	2,7	3,9	5,7	5,9

Balance de B, Mo y Se (g/ha/año) en sistema intensivo de vacas lecheras en pastoreo, manejadas en pradera de Ballica + trébol

	B	Mo	Se
Inputs			
Fertilización	6	7	0,3
Atmósfera	150	2	3
Reciclaje			
Absorción Forraje	150	40	10
Consumo animal	120	32	8
Material muerto	60	16	4
Raíces muertas	60	20	3
Excretas	96	26	6,5
Output			
Leche	7	0,7	0,2
Pérdida por lluvia	60	1	1
Pérdida por excretas	17	5	1,2
Ganancia/Pérdida en el suelo	82	2	0,6

Funciones del Boro

- Asociado a la actividad metabólica
- Translocación de azúcares
- Síntesis de hormonas
- Formación de la pared celular
- Desarrollo celular

Deficiencia de Boro en la Planta

- Reduce el crecimiento vegetativo
- Disminuye la floración
- Disminuye la elongación radical

Concentración de Boro en el Suelo

- 0.2 - 1.5 ppm Niveles habituales en el suelo
- < 1 ppm Se considera nivel deficiente
- Exceso de Boro en el suelo reduce la germinación de las semillas

Nivel de Boro en la Planta

- Existe mayor concentración en plantas dicotiledoneas
- Concentración crítica
  - Trébol blanco 13 - 16 mg/kg ms
  - Trébol rosado 15 - 18 mg/kg ms
  - Alfalfa 17 - 18 mg/kg ms
  - Ballica perenne 6 - 12 mg/kg ms
  - Pasto ovillo 6 - 12 mg/kg ms
  - *Phleum pratense* 6 - 12 mg/kg ms

Requerimientos de Fertilización con Boro

- En Chile existe respuesta de hasta 6 kg Boro/ha en Trébol rosado
- En praderas permanentes se aplica hasta 2 kg Boro/ha
- La mayor respuesta se presenta en Coles, Remolacha y leguminosas forrajeras
- En Nueva Zelandia se aplica 0.5 kg B/ha ó 2.5 kg B/ha cada cuatro años

Rol del Boro en el Animal

- Influencia en el metabolismo del Calcio, Fósforo y Magnesio

Requerimientos de Boro en el Animal

- No es un elemento esencial
- Consumo excesivo provoca:
  - Edema en las patas
  - Reduce el consumo
  - Reduce el crecimiento

Alfalfa






Nivel de Nutrientes en la Planta

N	>5.0
P	0.71-1.0
K	3.6-5.0
Ca	3.0-4.0
Mg	1.1-2.0
S	>0.50
B	>80
Cu	31-50
Fe	251-400
Mn	100-250
Mo	>5.0
Zn	71-100

Requerimientos para producir 20 ton ms/ha

	1 ton	20 ton
P_2O_5	7	140
K_2O	29	580
Ca	15	300
Mg	3	60
S	3	60
B	0.04	0.8
Mo	0.001	0.02
Zn	0.027	0.5

Deficiencia de Boro en la Planta

- Reduce el crecimiento vegetativo
- Disminuye la floración


Nivel de Nutrientes en la Planta

Elemento	Niveles %
N	>5.0
P	0.71-1.0
K	3.6-5.0
Ca	3.0-4.0
Mg	1.1-2.0
S	>0.50
B	>80
Cu	31-50
Fe	251-400
Mn	100-250
Mo	>5.0
Zn	71-100

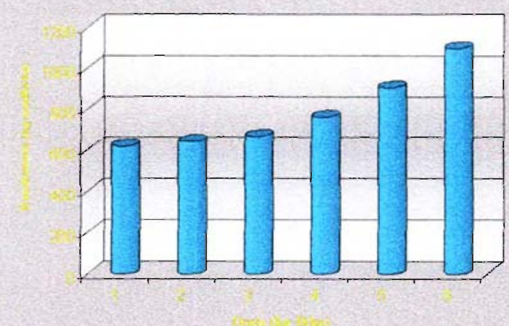
El Boro en la Producción de semilla Trébol rosado

El Boro es escencial en la elongación del tubo polínico

Efecto de la aplicación de Boro en la producción de semilla de Trébol rosado

kg B/ha	99/00	00/01	Sumatoria	%
0	619	821	1.440	100
1	639	1.146	1.785	124
2	664	1.168	1.832	127
3	760	1.389	2.149	149
4	906	1.393	2.299	160
6	1.096	1.401	2.497	173
Promedio	**781**	**1.220**	**2.000**	**139**

Efecto de la dosis de boro en la producción de semilla de Trébol rosado. Maquehue. Temporada 1999/2000



17th Congreso Mundial de la Ciencia del Suelo

Enfrentando la Nueva Realidad del siglo 21

Agosto 2002, Bangkok Thailandia

GOBIERNO DE CHILE
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INNOVACIÓN AGRARIA

**Artículo Presentado al Comité Editor de la Revista Técnica
Frontera Agrícola**

PRODUCCION DE SEMILLA DE TREBOL ROSADO

Rolando Demanet Filippi.
Ingeniero Agrónomo, Instituto de Agroindustria Universidad de La Frontera
María de la Luz Mora Gil.
Doctora en Química de suelos, Instituto de Agroindustria Universidad de La Frontera

En la Región de la Araucanía y específicamente en la provincia de Cautín, se establecen anualmente 5.000 ha de Trébol rosado, las cuales son destinadas a la producción de forraje y semilla. La tecnolo´gia que presentan los productores de semilla ha permitido mantener un rendimiento promedio de semilla de 250 kg semilla/ha, sin embargo, los resultados logrados por el proyecto FONDEF D97I2005, realizado por un grupo superior a 20 profesionales de la Universidad durante cuatro años, logró demostrar que es factible alcanzar niveles de rendimiento mayores a 1.000 kg de semilla/ha en forma estable en el tiempo.

La información generada por el proyecto en relación a la producción de semilla de Trébol rosado, esta indica que es absolutamente factible lograr un alto rendimiento de semilla durante la temporada de establecimiento, donde se debe considerar el establecimiento temprano en otoño. Además, este cultivo puede ser cosechado en la segunda temporada (Cuadro 1), para lo cual se debe considerar su utilización invernal y aplicación de herbicidas (Paraquat y otros), para el control de especies de hoja ancha y gramíneas.

Cuadro 1: Efecto de la edad del semillero de Trébol rosado sobre el rendimiento (kg semilla/ha). Estación Experimental Las Encinas. Temporadas 98/99 – 99/00. Temuco, IX Región

Distancia entre Hilera (cm)	Primera Temporada	Segunda Temporada	Sumatoria	Promedio
17	1.039	778	1.817	909
34	1.042	929	1.972	986
51	932	419	1.351	676
Promedio	**1.004**	**709**	**1.713**	**856**
%	**59**	**41**	**100**	

Respecto al manejo agronómico de este cultivo, los resultados demostraron que una densidad de 400 plantas/m^2 y distancia entre hilera de 17 cm, permiten alcanzar rendimientos superiores a 1000 kg semilla/ha. (Figura 1 y 2)

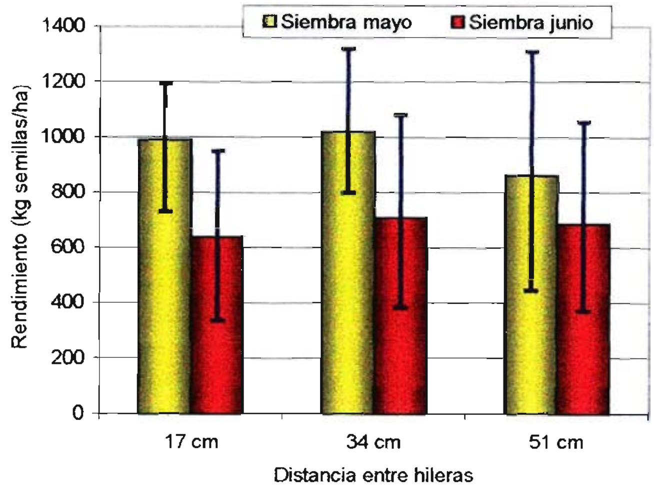


Figura 1. Efecto de la distancia entre hileras sobre la producción de semilla de trébol rosado.

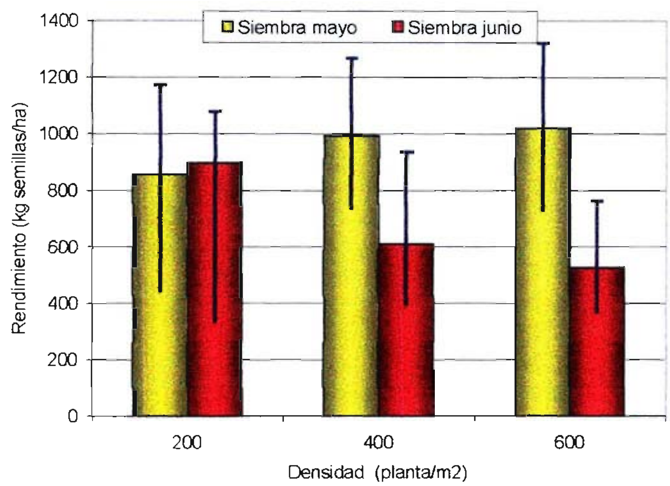


Figura 2. Efecto de la densidad de plantas sobre la producción de semilla de trébol rosado.

En el área central de la IX Región, el establecimiento de esta leguminosa asociada a un cereal, no tiene interferencia sobre la producción de semilla de esta leguminosa durante la segunda temporada, en especial, cuando se siembra asociado a Triticale o Cebada (Figura 2).

Cuadro 2. Asociación con cereales, distancia entre hilera y dosis de semilla en *Trifolium pratense*. Estación Experimental Maipo

Primera Temporada 1997/1998.Producción Cereales (qqm/ha)

Distancia entre hilera cm	Dosis de semilla kg	Asociación Trébol-Cereal Triticale	Cebada	Avena
Testigo		69	37	73
20	4	78	41	53
	8	73	41	48
40	4	66	48	56
	8	74	37	58
Promedio		72	41	58

Segunda Temporada 1998/1999.Producción de *Trifolium pratense* (kg/ha)

Distancia entre hilera cm	Dosis de semilla kg	Trébol	Asociación Trébol-Cereal Triticale	Cebada	Avena
20	4	1.561	1.576	1.420	1.061
	8	1.720	1.409	1.247	1.072
40	4	1.656	1.164	1.542	942
	8	1.437	1.338	1.527	1.055
Promedio		1.594	1.372	1.434	1.033

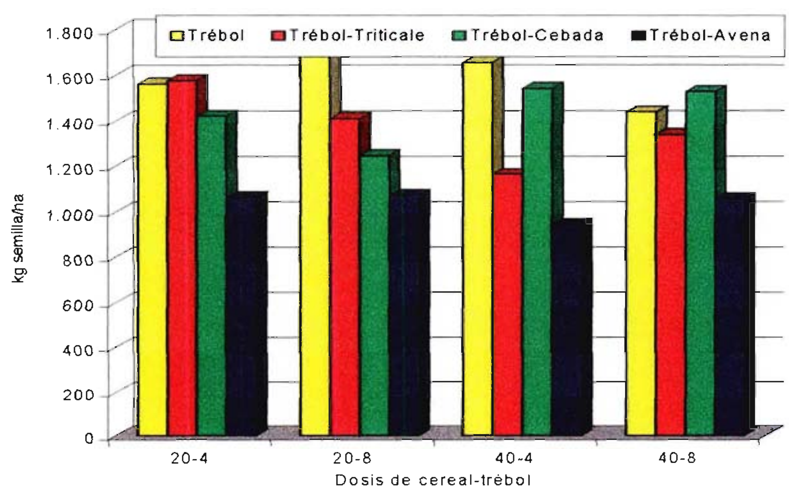


Figura 3. Asociación con cereales, distancia entre hilera y dosis de semilla en *Trifolium pratense*. Estación Experimental Maipo

INOCULACIÓN Y PELETIZACION

Cabe destacar que para lograr un alto rendimiento de semilla, es clave el manejo de establecimiento de esta leguminosa. En primer término se debe considerar la peletización con molibdeno, hecho que permite incrementar en mas de 40% el rendimiento de semilla (Figura 4).

Cuadro 3. Efecto de la inoculación y peletización con molibdeno sobre la producción de semillas de *Trifolium pratense*. Gorbea.

Tratamientos	kg semilla/ha		% Incremento
	Sin Mo	Con Mo	
(I_0)Testigo	1.119	1.579	41
(I_2)U 28	755	1.349	79
(I_3)Exp 1	929	1.205	30
(I_4)Exp 2	1.083	1.471	36
(I_5)Inoculante comercial	966	1.231	27
Promedio	970	1.367	41

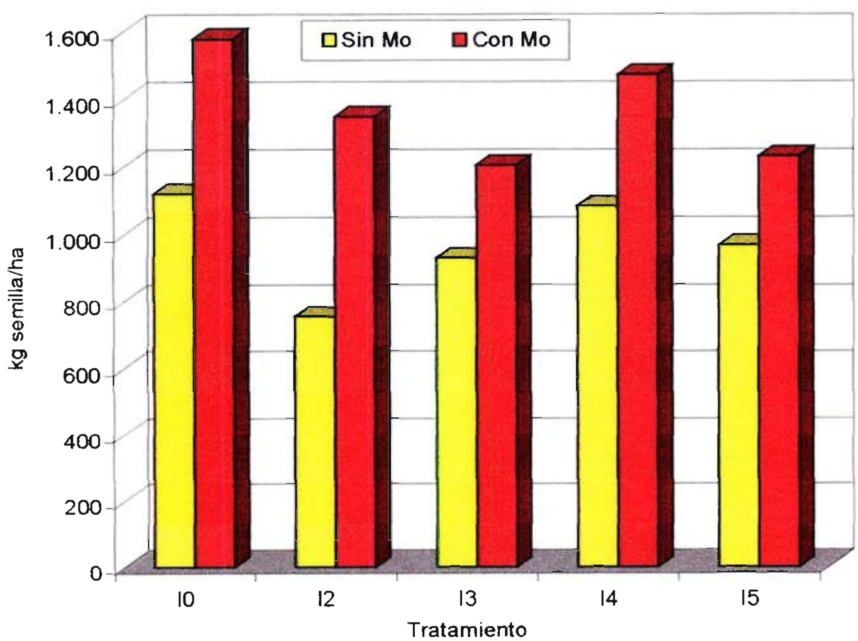


Figura 4. Efecto de la inoculación y pelitización con molibdeno sobre la producción de semillas de *Trifolium pratense*. Gorbea.

FUENTES DE FOSFORO

Además, al establecimiento se debe considerar la aplicación total de fósforo, en especial, cuando se utilizan fuentes de baja solubilidad y lenta entrega (Figura 5). Este elemento cumple un rol fundamental en el proceso de floración y en la formación de las semillas, y su disponibilidad debe ser óptima en el periodo previo a la formación de estas estructuras.

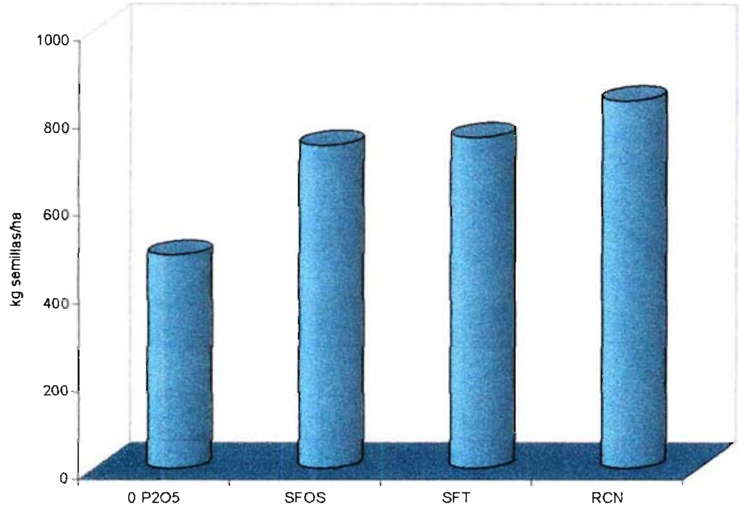


Figura 5. Efecto de la fuentes de fósforo sobre la producción de semilla de *Trifolium pratense*. Gorbea

USO DE ENMIENDA EN PRODUCCIÓN DE SEMILLA DE TREBOL ROSADO

El azufre, calcio y magnesio son nutrientes que cumplen un rol fundamental en el desarrollo de las leguminosas. El Azufre es constituyente de las proteínas, más precisamente de los aminoácidos cisteína y metionina, y de las vitaminas tiamina y biotina, así como la coenzima A. El calcio que mayormente poseen las plantas se encuentra en las vacuolas centrales y en las paredes celulares unidos a polisacáridos llamados pectatos. Por otra parte este elemento en el suelo permite la regulación de los nivles de pH y porcentaje de saturación de Al, situación de alta trascendencia en los Andisoles acidificados de la Región, donde se desarrolla la multiplicación de semilla de trébol rosado. El magnesio, en la planta se ubica en la molécula de clorofila y resulta un elemento esencial porque se combina con el ATP y participa en la activación de diversas enzimas necesarias para el proceso de fotosíntesis, respiración y formación de ADN y RNA. En las evaluaciones realizadas en este proyecto, en un Andisol, la aplicación de mezclas de dolomita mas sulfato de calcio, permitieron elevar el rendimiento de semilla en 67% (Cuadro 5 y Figura 6)

Cuadro 5. Efecto de la dosis de enmienda en la producción de semilla de *Trifolium pratense*. Las Encinas.

Dosis	Primera temporada	Segunda temporada	Total
Testigo	508	694	1.202
250 Yeso - 250 Dol	521	716	1.237
500 Yeso - 500 Dol	464	1.113	1.577
750 Yeso - 750 Dol	861	1.146	2.007

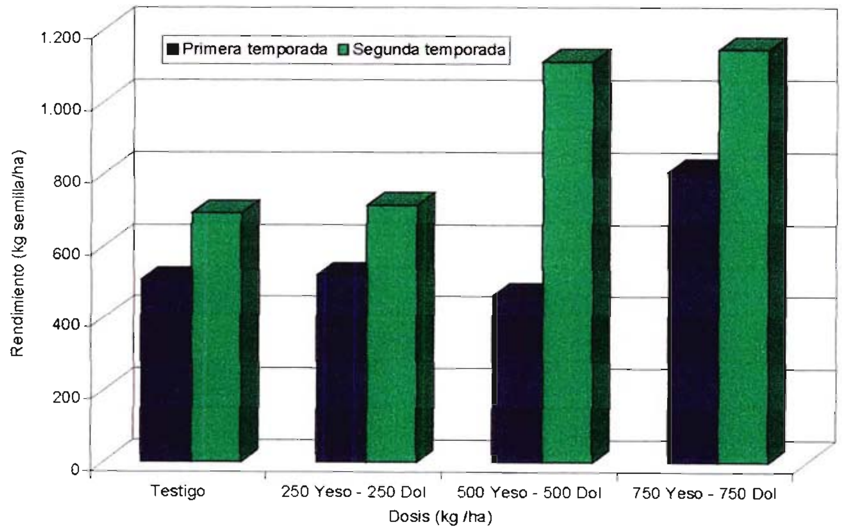


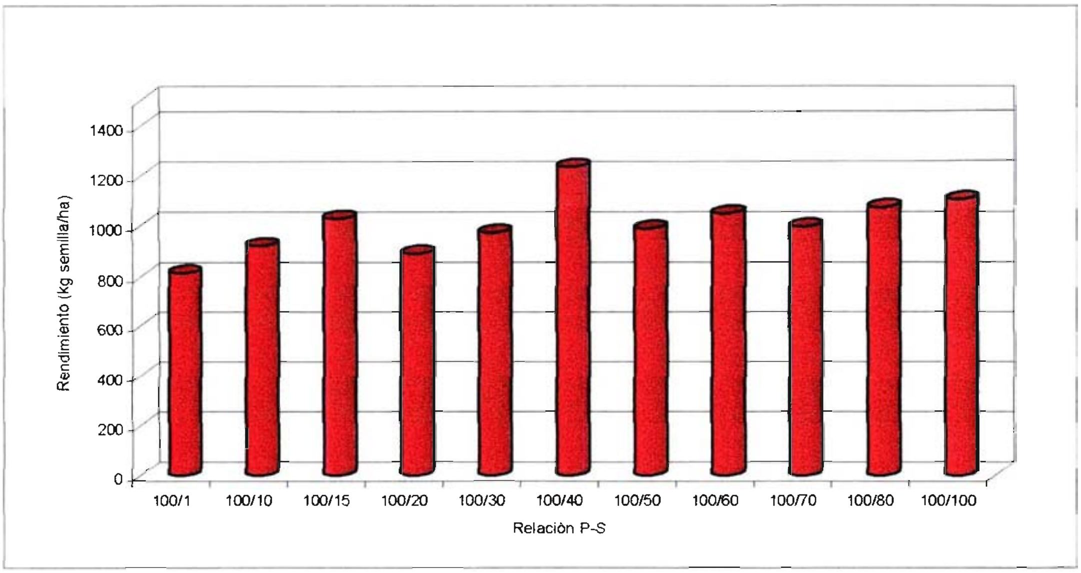
Figura 6. Efecto de la dosis de enmienda en la producción de semilla de *Trifolium pratense*. Las Encinas.

RELACION AZUFRE/FOSFORO

La relación fósforo azufre en el suelo y planta ha sido ampliamente estudiada por el grupo de investigación del Instituto de Agroindustria de la Universidad de La Frontera. En relación a la producción de semillas se realizó un ensayo en el predio Maquehue en un suelo Andisol, que demostró que la relación 100:40 fue la que logró en promedio de dos años el mayor rendimiento de semilla de trébol rosado, superando en 23% la producción del tratamiento testigo 100:0 (Cuadro 6).

Cuadro 6: Efecto de la fertilización con diferentes relaciones P/S sobre la producción de semilla (kg/ha) de *Trifolium pratense*, en un Andisol de la Región de La Araucanía. Temporadas 1999/2000 y 2000/2001. Maquehue.

P/S	99/00	00/01	Sumatoria	%
100/0	812	1.381	2.193	100
100/10	920	1.241	2.161	99
100/15	1.027	1.131	2.158	98
100/20	889	1.544	2.433	111
100/30	973	1.609	2.582	118
100/40	1.235	1.452	2.687	123
100/50	989	1.081	2.070	94
100/60	1.049	1.331	2.380	109
100/70	996	1.099	2.095	96
100/80	1.073	1.381	2.454	112
100/100	1.100	1.386	2.486	113
Promedio	**1.006**	**1.330**	**2.336**	**107**



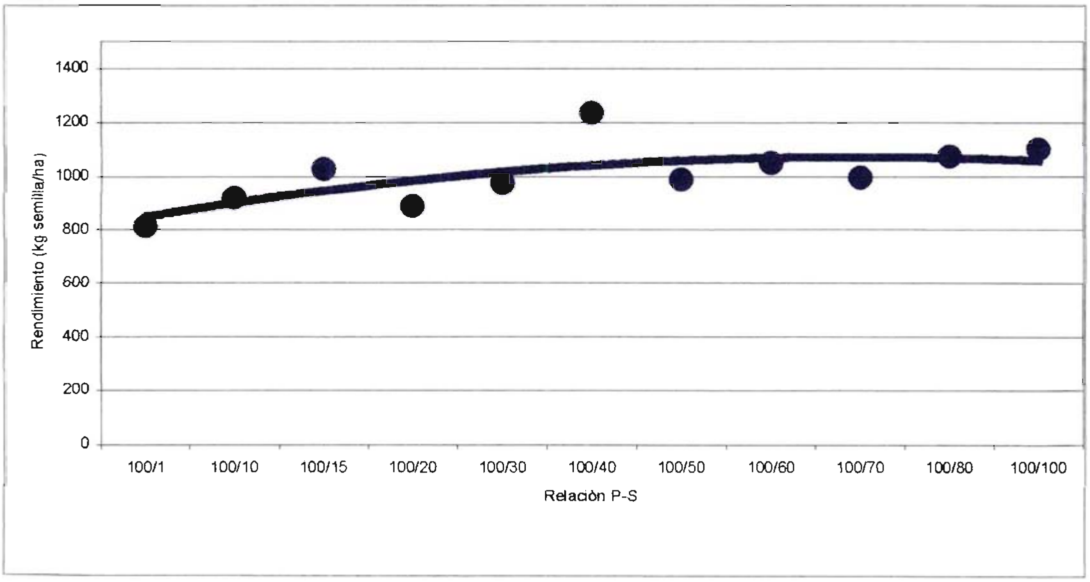


Figura 7: Efecto de la fertilización con diferentes relaciones P:S sobre la producción de semilla (kg/ha) de *Trifolium pratense*. Maquehue. Primera Temporada (1999/2000).

USO DE POTASIO EN PRODUCCIÓN DE SEMILLA DE TREBOL ROSADO

En relación a la fertilización con potasio, este cultivo presenta una alta respuesta a la aplicación de este elemento, dado que participa en la formación de las estructuras de la planta. Una mayor eficiencia se logra cuando el potasio es aplicado en forma parcializada (Figura 8), dado que es posible escapar a los procesos de lixiviación que se producen en forma habitual en la Región, producto de la concentración de las precipitaciones. Como se observa en los siguientes cuadros, la tendencia se verifica en áreas de Andisoles y Utilsoles y bajo condiciones diferentes de humedad de suelo.

Cuadro 7. Dosis y parcialización de potasio en la producción de semilla de *Trifolium pratense* (kg semilla/ha) en Andisol. Maquehue. Temporadas 1999/2000 y 2000/2001.

kg K_2O/ha	kg K_2O/ha	99/00	00/01	Sumatoria	%
0	0	252	820	1.072	100
70.0	70	722	950	1.672	156
70.30	100	810	1.159	1.969	184
70.50	120	833	1.208	2.041	190
70.70	140	795	1.290	2.085	195
Promedio		**682**	**1.085**	**1.768**	**165**

Cuadro 8: Dosis y parcialización de potasio en la producción de semilla de *Trifolium pratense* (kg semilla/ha) en Andisol. Las Encinas. Temporadas 1998/1999 y 1999/2000.

kg K_2O/ha	kg K_2O/ha	98/99	99/00	Sumatoria	%
0	0	696	674	1.370	100
0-60	60	729	768	1.497	109
30-60	90	678	790	1.468	107
60-60	120	794	860	1.654	121
90-90	180	780	1.010	1.790	131
Promedio		**735**	**820**	**1.556**	**114**

Cuadro 9: Dosis y parcialización de potasio en la producción de semilla de *Trifolium pratense* (kg semilla/ha) en Untisol. Nueva Imperial. Temporada 1998/1999.

kg K_2O/ha	kg K_2O/ha	kg semillas/ha	%
0	0	120	100
0-90	90	139	116
30-60	90	144	120
90-90	180	215	179
Promedio		**155**	**129**

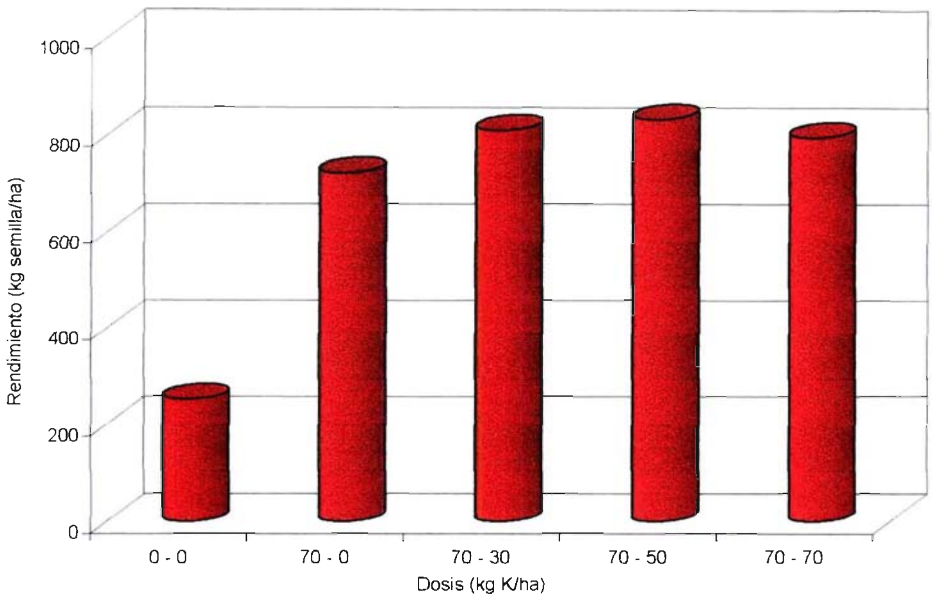
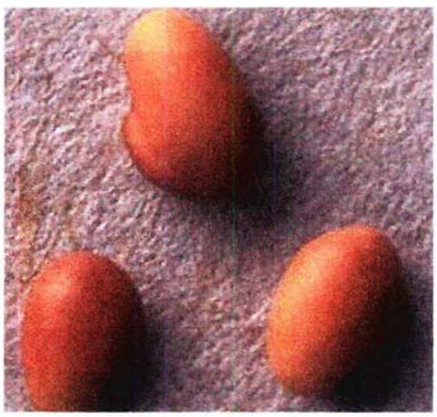


Figura 9: Dosis y parcialización de potasio en la producción de semilla de *Trifolium pratense*. Maquehue. Primera temporada



APLICACIÓN DE BORO EN SEMILLEROS DE TREBOL ROSADO

La aplicación de Boro genera una alta respuesta en producción de semilla de Trébol rosado (Figura 9). Esto se encuentra asociado a una mayor producción de néctar, elongación del tubo polínico y desarrollo del polen, situación que permite obtener una mayor eficiencia de los agentes polinizantes.

Cuadro 10. Efecto de la dosis de boro en la producción de semilla de *Trifolium pratense* (kg semilla/ha). Maquehue. Temporada 1999/2000 y 2000/2001

kg B/ha	99/00	00/01	Sumatoria	%
0	619	821	1.440	100
1	639	1.146	1.785	124
2	664	1.168	1.832	127
3	760	1.389	2.149	149
4	906	1.393	2.299	160
6	1.096	1.401	2.497	173
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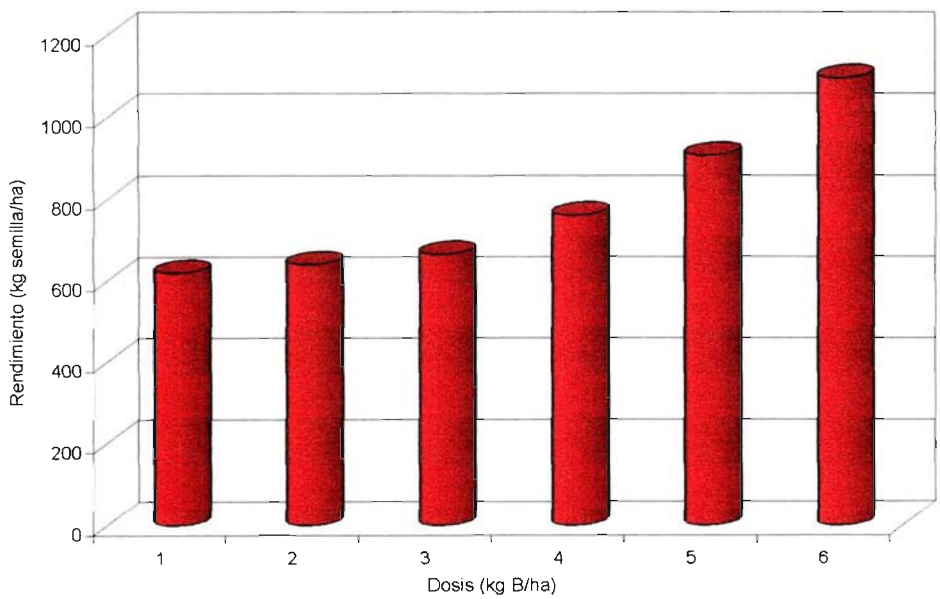

Figura 9. Efecto de la dosis de boro en la producción de semilla de trébol rosado. Maquehue. Temporada 1999/2000

EFECTO DEL RIEGO EN LA PRODUCCIÓN DE SEMILLA DE TREBOL ROSADO

En áreas con déficit hídrico prolongado (Nueva Imperial), la aplicación de agua de riego durante el periodo estival provoca una alta respuesta en producción de semilla, generando una diferencia superior a 600 kg/ha, entre la situación de secano y cuando se utiliza riego para suplir el 75% de la evapotraspiración. Niveles excesivos de aplicación de agua de riego, reduce la producción de semilla, como consecuencia del aumento de la producción de follaje (Cuadro 11 y Figura 10).

Cuadro 11: Efecto de diferentes cargas de agua de riego sobre la producción de semillas de *Trifolium pratense*. Nueva Imperial

% EvP	98/99	99/00	Sumatoria	%
0	123	458	581	100
50	441	1.122	1.563	269
75	711	1.252	1.963	338
100	151	1.351	1.502	259
Promedio	**357**	**1.046**	**1.402**	**241**

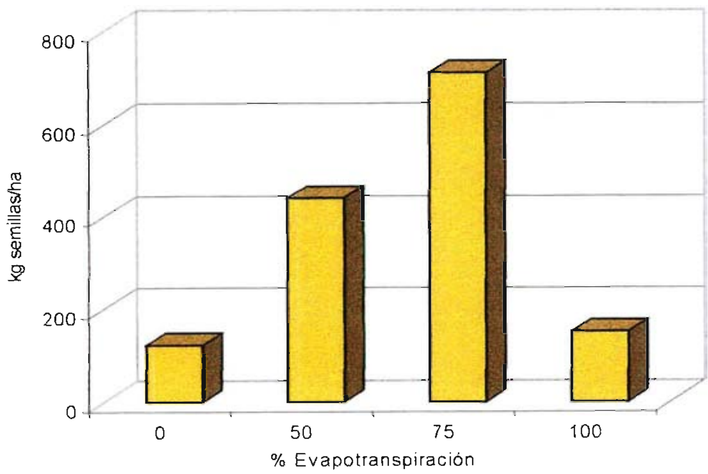

Figura 10. Efecto de diferentes cargas de agua de riego sobre la producción de semillas de Trébol rosado. Nueva Imperial

EFECTO DEL REZAGO EN LA PRODUCCIÓN DE SEMILLA

En los semilleros de segundo año, el manejo del follaje durante el periodo invernal exige que el tiempo de rezago no se extienda mas allá de fines de agosta a principio de septiembre (Figura 11).

Cuadro 12. Efecto de la época de rezago en la producción de semilla de *Trifolium pratense*. Las Encinas. Segunda temporada

Rezago	kg semilla/ha	%
Desde 4 de Agosto	938	100
Desde 8 de Octubre	364	39
Desde 21 de Octubre	367	39
Desde 5 de Noviembre	340	36
Promedio	**502**	**54**

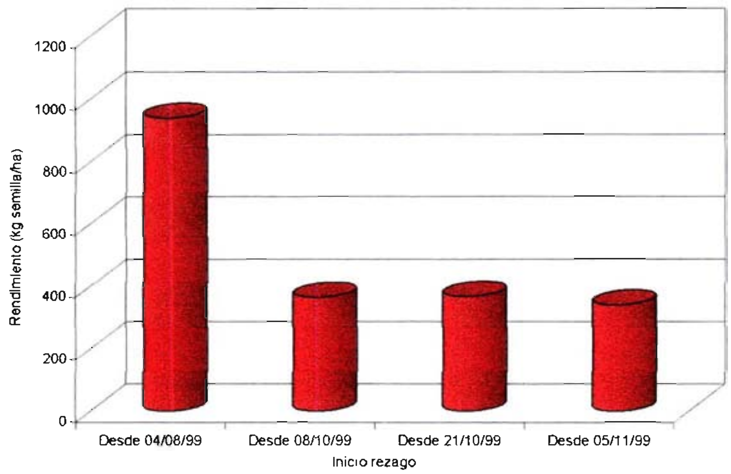

Figura 11. Efecto de la época de rezago en la producción de semilla de *Trifolium pratense*. Las Encinas. Segunda temporada

UTILIZACIÓN DE DESECANTES

En el periodo de cosecha es habitual la ocurrencia de precipitación, situación que provoca serios daños en la calidad y cantidad de semilla cosechada. Una alternativa de mejorar la labor de extracción de la semilla y acelerar el proceso de cosecha es a través de la utilización de desecantes. Las evaluación realizadas demostraron que los desecantes presentes en el mercado nacional no generan pérdida en la calidad de la semilla y permiten un leve incremento en el rendimiento final de semilla (Cuadro 13).

Cuadro 13: Efecto de la aplicación de desecantes en la producción de semilla de *Trifolium pratense*. Las Encinas, Primera temporada de cosecha.

Desecante	kg semillas/ha	%
Directa	531	100
Paraquat	632	119
Paraquat + Diquat	632	119
Promedio	**598**	**113**

POLINIZACIÓN DE TREBOL ROSADO

La polinización es uno de los procesos que limita en áreas de la Región la producción de semilla de Trébol rosado. Aun cuando, la producción y multiplicación de los agentes polinizantes es una etapa pendiente en este proyecto, pero que sin embargo, se continúa trabajando en ello. Las evaluaciones realizadas por el académico Ramón Rebolledo S., permitieron definir claramente la mayor eficiencia de *B. ruderatus* sobre *B. dahlbomi* en trébol rosado, tanto en tiempo de visita como la frecuencia de estos sobre las flores del trébol. También fue posible observar que es en Nueva Imperial el lugar en donde hay más *B. ruderatus* y por tanto también una mayor actividad del insecto sobre flores de trébol rosado.

Dentro de las observaciones realizadas se vio, que en general, en las horas de mayor calor (entre 13:00 a 16:00), ambas especies de *Bombus* descansan sobre hojas de cualquier árbol,. Para así pasar las horas más calurosas, siendo la abeja en estos momentos más activa, pero también se pudo comprobar en terreno, que las abejas a pesar de su abundancia, no trabajan bien la inflorescencia del trébol rosado, dado la dificultad morfológica que estas flores presentan a las abejas. También se apreció que es en las horas de mayor calor, cuando ocurre le fecundación de las hembras, hecho que toma lugar en partes altas de diferentes especies de árboles.

Por último, con respecto a la presencia del insecto en la región, fue posible corroborar que *Bombus ruderatus* es una especie que se encuentra en todas las comunas de la IX Región, pero que, sin embargo, su mayor abundancia relativa se da hacia los lugares costeros; siendo observado sobre diferentes hospederos además del trébol rosado, en especial, plantas espontáneas como *Cirsium* spp., y varias leguminosas cultivadas, tales como haba y una larga lista de plantas ornamentales que hacen de *B. ruderatus* una especie muy importante en la polinización de variadas especies vegetales, tanto cultivadas como espontáneas.
En los estudios de polinización se observó que tres especies del género *Bombus* estudiadas; *B. dahlbomi*, *B. ruderatus* y *B. terrestris*, son polinizadores efectivos de trébol rosado. No fue posible criar artificialmente a *B. dahlbomi* y *B. Ruderatus* dada la alta sensibilidad al estrés mostrada por las reinas, especialmente de la especie *B. ruderatus*. En todas las temporadas, se contabilizó un alto número de reinas en la zona; sin embargo, sólo un

porcentaje reducido de ellas logró formar colonias exitosamente. Algo importante de destacar fue que los roedores fueron una de las causas probables del bajo número de reinas que consiguieron formar colonias. En el 80% de los nidos artificiales dispuestos en campo, se hallaron evidencias de la presencia de estos mamíferos.

Por otra parte, *Bombus terrestris* mostró ser un efectivo polinizador de trébol rosado, particularmente las reinas y obreras de gran tamaño, quienes prefirieron pecorear las flores de este cultivo. Su efecto sobre la producción de semillas es probablemente menor al de las otras especies de moscardón presentes en la región, dado que las obreras de menor tamaño, tienen problemas para aprovechar el néctar de flores con corola profunda, como las de trébol rosado, a causa de su probóscide más corta.

En los ensayos realizados para medir la capacidad polinizadora de *B. terrestris*, el mejor resultado fue obtenido por el tratamiento "polinizadores naturales", constituido por *Apis mellifera*, *B. dahlbomi* y *B. ruderatus*, cuyo rendimiento fue, en promedio, cinco veces mayor que el obtenido por *B. terrestris*; el cual a su vez, superó al testigo en diez veces su rendimiento. Asimismo se comprobó un detrimento del rendimiento en el tratamiento "polinizadores naturales", como consecuencia de la sombra; cuyo efecto redujo en aproximadamente siete veces la producción de dicho tratamiento. Si bien, los resultados no son extrapolables, es probable que el rendimiento obtenido por los otros tratamientos, también haya sido afectado por la sombra.

También fue posible comprobar la falta de coincidencia entre la floración del cultivo y la población de moscardones presentes en el cultivo, al observar que el número de individuos en el ensayo, sólo aumentó a partir del mes de febrero. Esta situación concuerda con los planteamientos realizados por otros investigadores, quienes aseguran que esto impide conseguir mayores rendimientos en la producción de semilla.

Cuadro 14: Polinización de *Trifolium pratense* con *Bombus ruderatus*

Especie	Fecha	Flores/Inflorescencia	Tiempo (seg)
Bombus ruderatus	6 de enero	5,8	17,6
	14 de enero	7,0	14,8
	21 de enero	6,3	9,9
	28 de enero	7,4	15,7

Cuadro 15: Polinización de *Trifolium pratense* con *Bombus ruderatus y Bombus dahlbomi*

Especie	Fecha	Flores/Inflorescencia	Tiempo (seg)
Bombus ruderatus	4 de febrero	6,6	15,9
	11 de Febrero	6,2	15,1
Bombus dahlbomi	4 de febrero	6,1	9,8
	11 de Febrero	5,5	10,0

ASISTENCIA A CHARLAS DE DIFUSION

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ASISTENTES A ACTIVIDAD DE DIFUSIÓN

Nombre	Actividad Principal	Institución o Empresa	Teléfono Fax e-mail
Jaime Santander		Sofo	403100
Juan Delgado Cardona		Indap Pitrufquen	391069
Juan R. Delgado Castro		Cooperativa Huilliche	733666
Cristina Muñoz	Estudiante	UFRO.	09-6748538 munozm@ufro.cl.
Jonathan Redel	✓	✓	406173 redely@ufro.cl
Andres Salinas P.		Indap. Gorbea	491800 solpalmas@Hotmail
Andrea Vera		SG 2000 Ltda	741020 sg2000@surnet.c
Howard Lange	Estudiante	UFRO.	318748 LangeH@ufro.cl
Luis Rivillo		Indap T. Schmidt.	664037

Abel Villeben		Ludop T. Schmidt	664037
Andrea Kröbuch		Sofo.	403100
Claudia Castillo	Post grado	UFRO.	731455
Martin Zamora	Ingeniero Agronomo	Cargill	09-7990034
Fernando Borie		UFRO	325430
Gonzalo Herrera	Ingeniero Agronomo	Cargill	749345 Oficina
Edith Montero		UFRO.	
Walter Lobos.		UFRO.	325055
Angelica Casanova.		UFRO.	325493
Goetz Palfner		U de Sheffield	

Victor Yañez	Ingeniero Agronomo	SQM.	210702 Vyanez@sqm.cl
Leonardo Garcia	Ingeniero Agronomo	S.Q.M.	210702 LGarcia@sqm.cl
Paola Sobarzo	Ing. Agronomo		284228/992029 ppadesh@yahoo.c
Tatiana Floody	Lab. Químico	UFRO	325494 tfloody@yahoo
Victoria Campos G.	Químico Laboratorista	UFRO	643998
Brigida Sobarzo B.	Químico analista	UFRO	325494
Noelia Sepúlveda	Químico Laboratorista	UFRO	325456
Jorge Pino Moromão	Ingeniero en Alimentos	UFRO	311352

ASISTENTES A ACTIVIDAD DE DIFUSIÓN

Nombre	Actividad Principal	Institución o Empresa	Teléfono Fax e-mail
Paula Cortés Zinda		UFRO	pcortes@ufro
Erika Vistoso	Estudiante Doctorado	UFRO	e.vistoso@ufro.cl
[illegible] Mora	Estudiante Doctorado	UFRO	mora@ufro.cl
Analy Rosas	Estudiante	UFRO	analr@ufro.cl
Pablo Cariqueo	Estudiante	INACAP	652201.
Juan Poblete A.	Estudiante	Inacap.	612241
Carolina Ordóñez S.	Estudiante	UFRO	405854
ARMANDO MERA SÁEZ	ESTUDIANTE	UFRO	8366583
Christian Neumann	Estudiante	Ufro	245796

ASISTENTES A ACTIVIDAD DE DIFUSIÓN

Nombre	Actividad Principal	Institución o Empresa	Teléfono Fax e-mail
Karina Quilodrán		UFRO	KARINAQ@UFRO.CL
Claudia Castillo		UFRO	731455
Rotama López		UFRO	lopezr@ufro.cl
Angélica Coronan		UFRO	nicoronov@ufro.cl
HOWARD LANGER		UFRO	Langerh@ufro.cl
CRISTINA MUÑOZ		UFRO	munozr@ufro.cl
Yonathan Redel		UFRO	redely@ufro.cl
Zeidareth Urmeñeta		UFRO.	